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Printed on thin paper for overseas circulation.

JUL 24 1939

The Engineer

VOL. CLXVIII.—No. 4357 28, ESSEX ST., STRAND, LONDON, W.C. 2 JULY 14, 1939

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A Seven-Day Journal

The "Thetis" Enquiry

DURING the week under review, the Tribunal appointed by the Government to enquire into the loss of the submarine "Thetis" has continued its sittings at the Law Courts, London, under the presidency of Mr. Justice Bucknill. One of the survivors, Mr. Shaw, of Cammell Laird and Co., Ltd., told what happened in the submarine up to the time of his escape, and during his evidence thanked Leading Stoker Arnold for his help when using the Davis escape apparatus. The salvage plans which were brought up to the surface by Captain Oram were produced. The Director of Naval Equipment, Vice-Admiral Tower, gave evidence as to the diving trial, and said that such a trial did not necessarily entail danger to those on board. Other evidence relating to the trials and the trim of the submarine was given by officials of Cammell Laird and the Naval Construction Department of the Admiralty. The evidence given on Friday, July 7th, went to show how baffling the problems are which face the naval and shipyard experts. As to the suggestion put forward by one of the counsel on Monday that there was delay in the effort made to salvage the "Thetis," Mr. Justice Bucknill described it as misleading and unfair. Further evidence was given on Tuesday by Mr. L. C. Williamson, Assistant Director of Naval Construction, who was closely questioned as to the possibility of an error in the operation of the mechanism for closing the bow caps. At this point the Attorney-General stated that certain information relating to the position of the bow caps had resulted from diving operations. The examination of the sunken ship by divers had also indicated a certain amount of damage to the fore end of the ship. For that reason, Sir Donald Somervell said that it might be dangerous to draw inferences from such examinations as had been made up to the present, and he proposed to wait until a later stage. If it was possible to raise the ship that evidence would become irrelevant, as it would be possible to see the actual vessel. On Tuesday afternoon, Admiralty officials gave particulars of the training in the use of Davis escape apparatus, of which 131 sets were aboard the "Thetis." Lieut. Coltart, who was aboard the accompanying tug "Grebecock," said that he did not like the look of the dive made by the submarine, and thought she had temporarily lost her trim; but his anxiety was allayed for the time being when smoke candles and marking buoys did not come at once to the surface.

New Naval Orders

ON Friday, July 7th, it was officially announced that, subject to the settlement of certain details, the Admiralty has decided to place orders for two minesweepers of the 1939 programme with each of the following firms:—Blyth Dry Docks and Shipbuilding Co., Ltd., of Blyth, with machinery by White's Marine Engineering Company, Ltd., of Hebburn-on-Tyne; and William Denny and Brothers, Ltd., of Dumbarton, with machinery by Harland and Wolff, Ltd. In a further announcement on Saturday, July 8th, it is stated that the Admiralty has decided to entrust the building of the eight destroyers of the "L" class to the firms mentioned below. Except where otherwise stated, the firms will build both the hulls and the propelling machinery of two vessels. On the Clyde orders have been placed with Scotts' Shipbuilding and Engineering Company, Ltd., of Greenock; Alexander Stephen and Sons, Ltd., of Linthouse, Govan; and the Fairfield Shipbuilding and Engineering Company, Ltd., of Govan. On the Tyne the Parsons Marine Steam Turbine Company, Ltd., has received the order for two ships, the hulls of which will be constructed by Vickers-Armstrongs, Ltd., at the firm's naval yard at High Walker-on-Tyne. The new "L" class destroyers are the largest destroyers now building for the Royal Navy; they have a displacement of 1950 tons, which is about 100 tons more than that of the "Tribal" class. The propelling machinery will consist of Parsons geared turbines taking steam from high-pressure Admiralty type boilers. The designed output of the machinery will be about 45,000 S.H.P., corresponding to a ship's speed of over 36 knots.

The Institution of Automobile Engineers

ON Wednesday last, July 12th, we were invited by the Chairman of the Automobile Research Committee, Mr. W. A. Tookey, to inspect the work in progress at the Research Department of the Institution of Automobile Engineers, at the research laboratories on the Great West Road, at Brentford. A great variety of interesting researches was on view in the various laboratories. In the Materials Testing Laboratory there is a Vickers projection microscope which gives a maximum magnification of 1000 diameters, and several micro-photographs of bearing and crank pin materials were shown. The buildings include chemical laboratories, a chassis laboratory, an engine test laboratory, and a general test laboratory, in addition to the material testing section mentioned above. In the engine laboratory important researches are being carried out on the questions of piston ring blow-by and flutter. A high-speed, single-cylinder engine, which is capable of sustained operation at speeds in excess of 6000 r.p.m., is being used in this connection for an investigation of the relation between piston ring design and gas leakage past the rings. The crank case of the engine has been sealed and connected to a large-capacity tank to minimise pressure fluctuations. The gas leakage past the rings into the crank case passes through this tank to a gasometer, where it is measured directly. Blow-by measurements have been made over a wide range of speeds, and the influence of side clearance and of radial pressure of the rings, cylinder bore distortion, rate of oil flow, and oil viscosity has been studied systematically. As a result of this work, a tentative theory of ring flutter has been formulated. Additional work of a similar character is being carried out with a production-type four-cylinder engine. In the general laboratory, the cold starting of petrol engines is being studied. The cold room, which has only recently been installed, can be operated at temperatures down to −25 deg. Cent., and is capable of accommodating two engines.

The Birmingham Airport

ON Saturday, July 8th, the new Birmingham Airport at Elmdon, on the road between Birmingham and Coventry, was opened by the Duchess of Kent. It is about twenty-five minutes' drive from the centre of the city, and sufficient space has been provided in the landing field and its approaches for the most modern types of aircraft to use it. There is a well-laid-out set of administration and public buildings, and additional hangars are to be built as they may be required. The latest equipment for the assistance and control of aircraft has been provided, and the city of Birmingham is now in a position to share in the development of civil flying. Among those present at the ceremony were the Prime Minister, Mr. Neville Chamberlain, and Mrs. Chamberlain, the Secretary of State for Air, Sir Kingsley Wood, and many other notable guests of the City Council. After unveiling a commemorative plaque in the main hall, the Duchess of Kent thanked Birmingham for the great welcome which had been accorded to her, and congratulated the city and all concerned on the establishment of a magnificent airport. The Prime Minister referred to the Royal Air Force, which, he said, was in many respects the finest in the world. The new airport was wisely planned, he said, for the future, and he looked forward to a great development in civil aviation. Sir Kingsley Wood said that we should never forget the real and beneficent object which science and invention intended for mankind by the navigation of the air. Aviation was intended to link the nations in the bonds of friendship and goodwill. The allocation of an Air Force squadron to the new airport was, he said, a reminder of the critical times in which we lived, and of the great and successful efforts which were being made in relation to British air defence and rearmament, efforts in which Birmingham had played its own part.

Progress of Civil Aviation

THE report on the progress of civil aviation, which was published by the Stationery Office on Monday, July 10th, shows that there has been a considerable extension in British civil flying services, both at home and in the Empire, and that fewer accidents have to be reported. Although the aircraft industry has been busily occupied with the demands of the rearmament programme, a notable advance in the design and development of civil types of aircraft is reported. In the course of the year the Air Ministry has placed orders for two new types of civil transport planes, and it has entered into an arrangement to subsidise the early production of a third type. In the British Empire a lead was established and maintained, not only as regards the total number of miles of route operated by regular air services, but also the numbers of civil aircraft. During the year the total number of registered aircraft in the Empire increased from 3197 to about 3260, the number of commercial pilots rose from 1955 to about 2200, while the number of private pilots was increased from 7542 to about 8700, and the ground engineers from 2961 to about 3500. There was a marked advance during 1938 in the distance flown and the number of passengers and weight of freight carried on the regular services, which are operated by the United Kingdom companies, including the internal services, the services between the United Kingdom and the Continent, the services which are operated by Imperial Airways and its associated companies on the Empire routes, and the Bermuda and New York service. It is estimated that on the regular internal air lines in Great Britain approximately 3,267,000 miles were flown and about 147,500 passengers and 1200 tons of freight and mail were carried. The number of route miles flown during the year, or a substantial part of it, was 5300, which showed an increase over the figure for the previous year. During 1938 the number of accidents, it is stated, was about half that of the previous year. In the House of Commons on Monday, July 10th, the British Overseas Airways Bill, which aims at the combination of the activities of Imperial Airways and British Airways in one public corporation, and includes far-reaching and important proposals for civil aviation, received its second reading and was referred to a Select Committee.

Anglo-Swedish Trade Talks

ROUND table discussions between various trade groups represented by British and Swedish manufacturers took place last week and ended on Friday, July 7th. Forty groups, including engineering, took part in the talks, and among the matters considered were the purchase by Sweden of British ship plates, ferro-manganese, tin-plates, machine tools, and chemical plant, and pig iron, and the general relations of the steel industry of Great Britain, Sweden, and the Continent. In a statement made at the concluding meeting on Friday, Mr. Peter Bennett, the President of the Federation of British Industries, said that many problems had been reviewed in such a friendly spirit and difficulties faced with such candour that quite a substantial increase in the sales of many British products to Sweden might be expected. On behalf of the British groups he said that they were grateful for the generous and practical advice on the needs of the Swedish market, and the types of products which were likely to win the approval of Swedish customers. Trade relations had been strengthened, but it would take time to develop the various schemes and suggestions which had been agreed upon. As an immediate step it had been decided to appoint a small committee, chosen from the members of the Swedish delegation, and a similar committee representing the Federation of British Industries, in order to consider jointly the best method of creating a permanent organisation to follow up the results of the present mission. Mr. Fredrik Goransson, the President of the Swedish Federation of Industries, and the leader of the Swedish delegation, said that his colleagues were very keenly aware of the generous reception they had received from British industry. When a return visit of British industrialists was paid to Sweden, not only a warm welcome would await them, but it would be possible still further to benefit mutual trade interests. The good will was present, and events of the week had served to strengthen it. He expressed the hope that the practical results of the conference would ere long be expressed in better trade returns.

Salving the "Thetis"

THE salving of the sunken submarine, H.M.S. "Thetis," which was begun on Monday, July 3rd, when the specially fitted-out salvage ship "Zelo," chartered by the Liverpool and Glasgow Salvage Association, which is in charge of the work, moored over the sunken ship, was delayed by the prevailing south-westerly gale, and up till Thursday the only connection between the submarine and the surface was one 4½in. wire fastened to a buoy. At midnight on Thursday the "Zelo" dragged her forward anchors and broadsided to the gale, carrying away two of the forward bollards. One 4½in. wire had been fastened to the "Thetis" and had been buoyed, and the fore reeving wire slipped. As there was no immediate prospect of such a moderation in the weather as was likely to permit of work being resumed, it was decided to recall the "Zelo" to Cammell Laird's repairing dock and to repair the damage and fit stronger bollards. Opportunity was taken to strengthen the ship in certain parts, and two strong winches were placed on board, which will be used to assist in pulling in the specially made 9in. wires for lifting the ship. The reeving wires already placed under the hull of the submarine will be used to thread the 9in. wires underneath the hull of the submarine. When the "Zelo" left for Birkenhead the attendant vessels sought shelter in the Moelfre Roads. On Tuesday morning, July 11th, the salvage steamer "Ranger" and the diving ship H.M.S. "Tedworth" proceeded to the site of the "Thetis" for the purpose of relaying heavy ground moorings and passing reeving wires under the submarine. H.M.S. "Tedworth" moored over the submarine at 9 a.m. on Tuesday morning and reported that the weather conditions were good. That being so, the "Zelo" proceeded to Liverpool Bay early on Tuesday morning. With the continuance of better weather it is hoped to make further progress with the salvage work.

The Paris-Neuilly Welded Bridge

A RECONSTRUCTION of bridges in and around Paris is a necessary part of the process of modernising roads to meet present traffic conditions. Among the roads leading out of Paris, the most important is that which extends in a straight line for nearly 4 miles from the Place de la Concorde in Paris to the Rond Point de la Defense at Courbevoie, where it branches out into three national roads. It comprises the Champs Elysées, Avenue de la Grande Armée, and the avenues of Neuilly and the Defense, which have been improved to give greater width to the roadway. This line of avenues crosses the Seine at Neuilly, where it is divided into two arms by the narrow end of the Ile de Puteaux. An old stone bridge was built on piers in the river as well as on the island. These piers were an obstruction that precluded merely widening the bridge, which had to be rebuilt, and the situation allowed of a special character being given to the bridge design. It provided (Fig. 1) for a deep architectural span of reinforced concrete over the island, and spans built up of welded steel sheet over the two arms of the river. The bridge had to harmonise with the general character of the most attractive thoroughfare out of Paris, for which reason the central concrete arch over the island is wider than the steel spans, and the arch and abutments are being faced with heavy masonry, while ramps and steps lead down to what will be ornamental gardens.

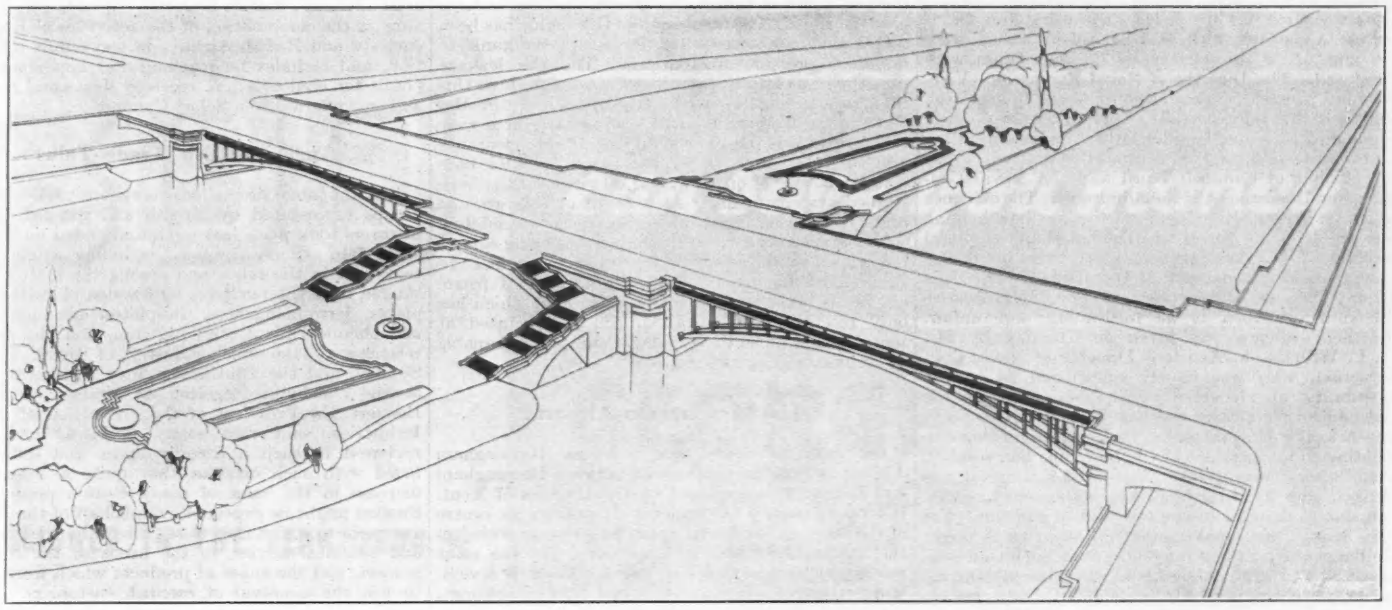


FIG. 1—ARCHITECT'S DRAWING OF COMPLETED BRIDGE

The total length of the bridge is 834ft., and the width between balustrades is 114ft. 9in. During the work of reconstruction there was to be no interruption to traffic. As the new bridge had to be built in the same axis as the old one, it could only be constructed in three stages, first on one side of the old bridge and then on the other side, and the two side bridges would then provide one-way traffic in opposite directions while the stone bridge was being dismantled and the new bridge completed. Operations began in 1936 by removing the mouldings on the sides of the old bridge as well as the lateral abutment extensions, so that the sides of the bridge were left bare of projections. Then followed the construction of reinforced concrete abutments on each side of what is left of the old ones, which will be reconstructed in their turn.

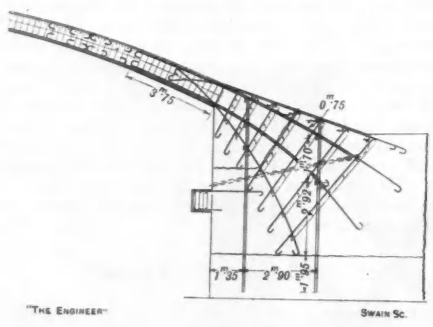


FIG. 2—ARCH REINFORCEMENT

The foundations are made in cofferdams of sheet piling down to limestone at a depth of about 33ft. below water-level. On the island the limestone lacked consistency and had to be treated with cement injection. The island concrete arch has a span of 105ft. and is 210ft. wide. The abutments for this arch have a reinforcement (Fig. 2) of rods of 35 mm. and 38 mm. diameter and of double-headed rails arranged vertically and horizontally. The weight of the rails is from 30 kilos. to 40 kilos. per metre, and they are from 10ft. to 26ft. long. They pass through adjacent blocks of concrete, 33ft. and more long, and 16ft. wide. The blocks have staggered flat projections fitting into corresponding recesses. At the springing of the arch the reinforcement consists of rods of 38 mm. diameter, forming a continuation of the top and bottom reinforcements of the arch with rods of 38 mm. and 30 mm. diameters. The arch is constructed in the usual way with ten balanced sections on the falsework, beginning with one each side of the keystone, followed by intermediate and abutment sections, and then completing the remaining sections in the same order (Fig. 4). After the concrete has set for not more than eight hours, the surfaces to be joined up with other sections are roughened, washed with water jets under pressure, and brushed. The abutments on each side of the river for the steel arches are extended behind to form subways for cross road traffic under the bridge in order to avoid interference with traffic

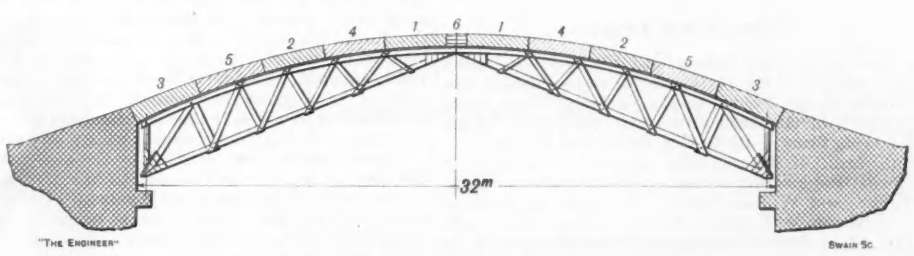


FIG. 4—ORDER OF CONCRETING CENTRAL ARCH

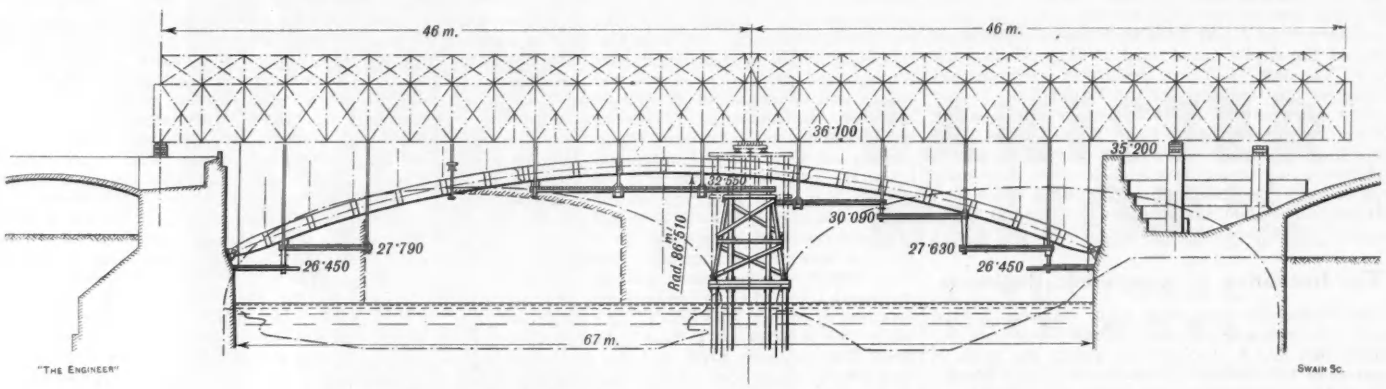


FIG. 3—SUSPENDED STAGING FOR ERECTION OF ARCH OVER SHORT RIVER SPAN

passing over it. All the concrete constructions are faced with heavy masonry.

About 63,000 cubic metres of concrete are employed in the construction of the bridge, and the whole of it is mixed by an automatic plant capable of producing 30 cubic metres an hour. This plant is the Hobbes, manufactured by Fiorantini, of Rome. Under the dumps of sand, gravel, and stones discharged from barges there are two tunnels down which run skips. When the truck arrives at the bottom of the incline, a horizontal door in a particular position under the dump swings open to load the truck to a predetermined quantity. One of the trucks is loaded with stones for ordinary concrete, and the other has two compartments for gravel and sand. The required proportions are adjusted by means of automatic controls, or one or the other may be cut out to load up with a single material. On being hauled to the top of the incline the sand and gravel are discharged into a hopper above a truck on rails with a compartment containing cement. This truck rises to a hopper above two concrete mixers and strikes a lever which opens the water supply, when the materials are discharged into the hopper with two outlets at the bottom that are put alternately into communication with the mixers. Each of these operations is controlled by an independent circuit with electric motors and winding and other mechanical gears, and all the circuits are connected up to form any desired combination by means of a rotating disc contact maker and breaker. Completely automatic working had to be abandoned for the plant installed at the Neuilly bridge because the concrete has to be discharged from the mixers on to conveyors, and a continuous and regular delivery on to the belt is therefore controlled by hand. There is no room for an intermediate device to ensure such regularity. There are three overlapping belt conveyors to a hopper above an Almacoa pump, which sends the concrete where it is required. This pump has an electrically driven horizontal piston which ends its stroke just beyond the bottom of the hopper, and the cylinder terminates in a circular casing containing valves for opening and closing a pipe that distributes the concrete. The valves are operated by rods from cranks on the ends of the piston crankshaft. The pipe rises over the middle of the bridge platform and extends to either end, so that it must have a length of nearly 500ft. For emptying and cleaning the pipe, sponges are driven through it under water pressure.

The steel construction over the arms of the river, with spans of 219ft. 9in. and 269ft., is entirely of welded steel plate (Figs. 3, 5, and 10), having a tensile strength of 54 kilos. per square millimetre, or 34 tons per square inch. Over each span there will be twelve arches having a rectangular cross section of 5ft. by 2ft. These dimensions are uniform throughout. The top and bottom plates of the longer span have a thickness of 22 mm. and the side plates 17 mm., these latter being welded within the edges of the bottom plate and flush at the top. The illustration, Fig. 7, shows how the arches are stiffened internally by strips, 80 mm. wide and 12 mm. thick, welded to all four sides in triangular section, and reinforced at the corners by gussets 15 mm. thick. They are joined horizontally by similar triangular sections. For the shorter span the thicknesses of the top and bottom plates are 18 mm. and 19 mm. respectively and the side plates 15 mm. These arches are delivered for erection in three lengths for the shorter span and in five lengths for the longer arm, and are electrically welded in position. At these vertical welds the arch is reinforced by an internal rectangular sleeve projecting from one end and centring the next length of arch. The sleeve has inside reinforcement plates cut out in their centres. As will be seen from the illustrations, Figs. 8 and 9, the vertical weld bends off in angles to the left and right at the top and bottom, and at the extremities of the vertical line lugs are welded for bolting together the bevelled ends of the arch sections for welding. The lugs are broken off when the weld is completed. The arches are joined laterally at distances of about 12ft. by similar built-up sections, and at their junctions square stanchions of welded steel sheet support rolled girders upon which the platform is laid. The concreted platform is 7in. thick. The reinforcement is shown in Fig. 6, as well as the pipe delivering concrete from the automatic mixing plant. All mains cross the bridge in a gallery under the footway.

There are no data yet available regarding the economy of the welded structure. Until a few months ago there was too much instability in the matter of costs to allow of any safe estimation, and all that can be done is to remark on the considerable amount of welding involved, mostly in the shops of the sub-contractors. It is affirmed, nevertheless, that there is an economy in weight of material. The time taken in erection also appears to be much reduced. The welds are verified by drilling out test pieces, and for another welded bridge to be put in hand soon photographic verification will be employed, though it is believed that the necessity for control will lessen with efforts being made to increase the supply of reliable welders.

As the bridge had to be rebuilt without encroaching on the width of the roadway or interfering with the river traffic, a construction bridge was

FIG. 5—SECTION OF SHEET STEEL ARCH

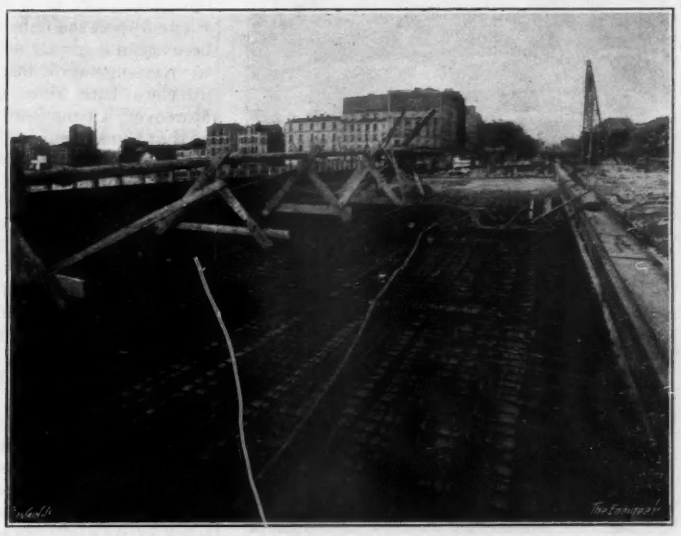


FIG. 6—REINFORCEMENT OF BRIDGE PLATFORM

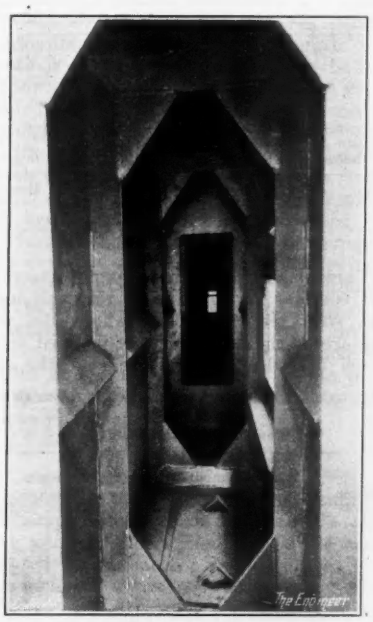


FIG. 7—STEEL ARCH REINFORCEMENT

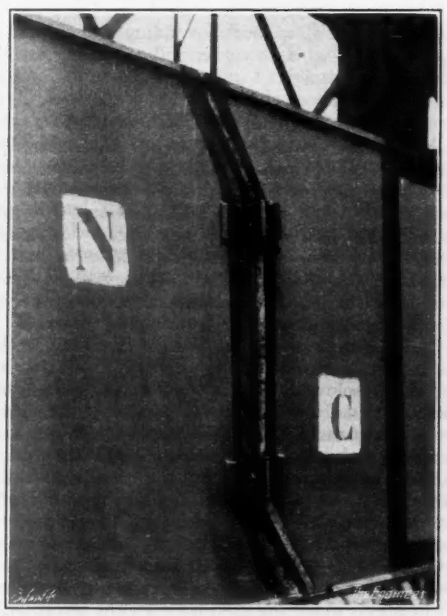


FIG. 8—ARCH SECTIONS BEFORE WELDING

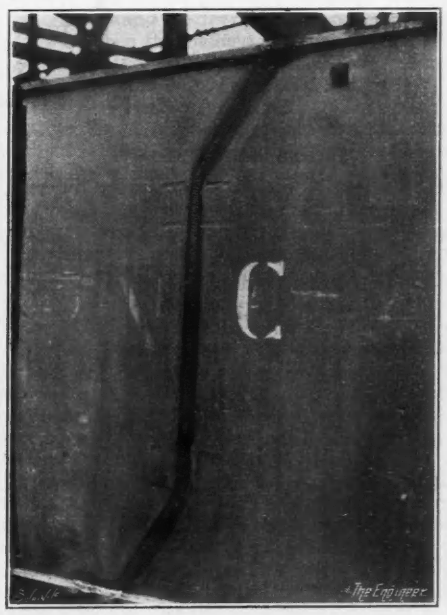


FIG. 9—AN ARCH WELD

prepared long enough to cross each arm of the river in turn. Built in two parts and bolted together, it is 39ft. wide, 19ft. high, and 305ft. long. Its weight is 250 tons. Temporary timber piers in line with the stone piers have to support the bridge. It is moved by hydraulic jacks and rollers in the usual way, first along one side of the old bridge, and then on the other side. The

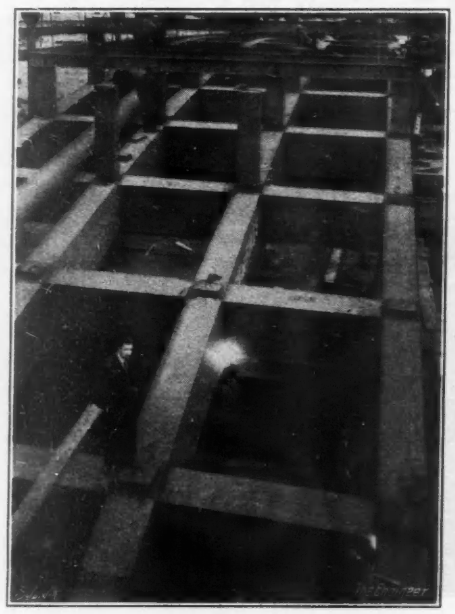


FIG. 10—TOP VIEW OF ARCH

construction bridge has two overhead travelling cranes, and (Figs. 11 and 12 on page 42), platforms are suspended from it for erection and welding. Another installation is a cableway between towers on each side of the river and capable of raising and carrying loads up to 3½ tons. The 1⅛in. cable has a working length of 970ft. The towers are 82ft. high. On the right side of the river the tower is constructed with two massive arms that form a triangle with the frame on which they are hinged. The frame is on wheels, and can be racked along on rails on a concrete abutment at an angle of 45 deg. At about 20ft. from the apex a vertical leg terminates in a cage loaded to something like 150 tons, resting on level rails. The vertical leg is trussed horizontally to the tower. The cable passes over the tower on the other side of the river to a counterweight.

In the engraving, Fig. 13 on page 42, an early stage of the reconstruction is shown.

Now that one side of the bridge is in service and the other side is nearing completion, work has started upon the demolition of the old bridge, and here again a special method has had to be adopted to overcome difficulties. No staging that might interfere with river traffic could be employed. Moreover, a time limit gave urgency to the work, so that the system adopted is to suspend a metallic falsework under the arches from above, that is to say, jointed steel arches are suspended at their ends against the piers by rods passing up through the bridge and attached to heavy cross bars resting on hydraulic jacks. The tension on the ends keeps the falsework in contact with the arches. The supports and hydraulic jacks are observable in Fig. 14, page 42, showing the old bridge being dismantled. There is no economy in this arrangement, except in time, which is in this case of the first importance. When the two sides of the bridge are in service, the dismantlement of the old bridge will be sufficiently advanced to permit of work being started immediately upon the central part of the new bridge. The reconstruction of the bridge is expected to be completed in the early part of next year. There was serious interruption to the work in its early stage through the troubles that began in the middle of 1936, and the estimated cost has risen to 72 million francs. The contractors are the Etablissements Léon Ballot for the reinforced concrete work and the dismantlement of the old bridge, and the Etablissements Baudet-Donon-Roussel for the metallic construction. The steelwork is supplied by the Etablissements Daydé and the Compagnie de Fives-Lille. The rebuilding of the bridge is under the direction of Monsieur Louis A. Lévy, engineer of the Ponts et Chaussées, who is also responsible for the reconstruction of the Suresnes and Saint-Cloud bridges.

Stress Conditions in a High Multiple-Arch Dam

By IVAN E. HOUK*

No. II

(*Continued from page 4, July 7th*)

DEAD LOAD STRESSES

FIG. 5 shows dead load stresses at different elevations in the multiple-arch units of Bartlett Dam. These stresses are due to concrete weight alone. They do not include effects of water pressure or concrete temperature change. Extrados and

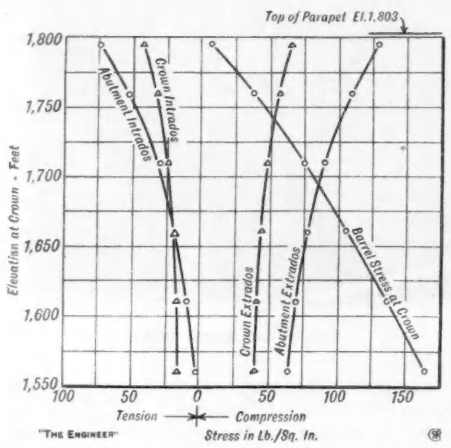


FIG. 5—*Arch and Barrel Stresses in Bartlett Dam Caused by Concrete Weight Load*

intrados stresses are shown for the crown and abutment sections of the inclined arch elements. Barrel stresses, that is, stresses caused by the portions of the dead load carried longitudinally down the barrel to the foundation, are shown only for a vertical cross section at the crown. Barrel stresses at other vertical cross sections through the multiple-arch units are only slightly different from those at the crown, the differences at corresponding elevations being due principally to the fact that the barrel thicknesses are constant in inclined planes instead of in horizontal planes.

The stresses shown on Fig. 5 need but little discussion. Barrel stresses increase gradually as the depth below the top of the dam increases, due to the gradually accumulating portions of the concrete weight carried down the barrel. Arch stresses decrease with increasing distances below the top of the dam, due to the fact that the increased thicknesses required to carry the increased water loads are more than sufficient to carry the increased dead loads. Arch stresses due to dead loads only are tension at the intrados and compression at the extrados, at both crown and abutment sections. At locations along the arch between the crown and abutments dead loads cause some tension at the extrados and some compression at the intrados—see Fig. 6.

COMBINED STRESSES

Table II shows the maximum tension stresses at the extrados and intrados, at the crown and abutment sections of the inclined arches, for the most severe combinations of loads, not including earthquake effects, wave effects, or beam action. Temperature and water loads causing the stresses are given at the bottom of the table. These stresses include effects of concrete weight. Table III shows similar data for maximum compressive stresses. Stresses for all inclined arches above tailwater surface are included in both tabulations. In the case of compression, maximum stresses at the abutment extrados of the arches at elevations 1795 and 1760, and at the crown extrados of the arch at elevation 1795, occur during the empty condition of the reservoir, as indicated by the footnote, instead of during the full condition, as given in the lower part of the table.

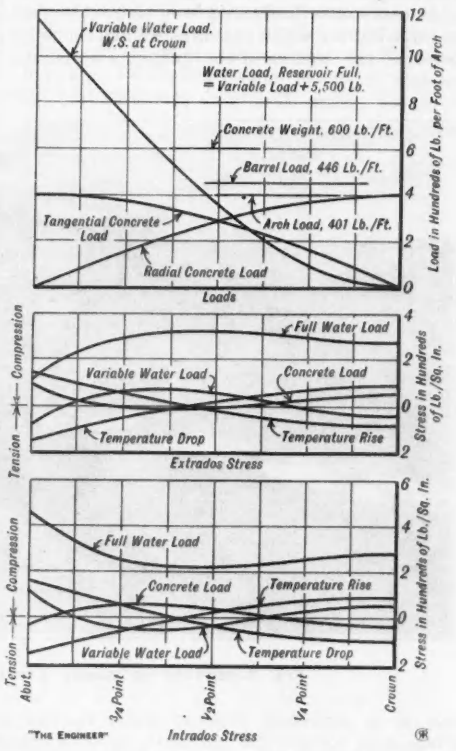


FIG. 6—*Loads and Stresses; Arch with Crown at Elevation 170*

The data in Table II show that maximum tension stresses at the extrados, the upstream face of the barrel, are caused by maximum temperature changes combined with variable reservoir loads; that is, with reservoir loads where the water surfaces are at the crowns of the inclined arches. Maximum extrados tensions occur at the abutments during conditions of minimum concrete temperature, and at the crown during conditions of maximum concrete temperature. At the intrados, the downstream face of the barrel, maximum tension stresses occur during the empty condition of the reservoir, the maximum occurring at the abutment during the assumed temperature rise, and at the crown during the assumed temperature drop.

The data in Table III show that maximum

TABLE II.—*Tension Stresses during Most Severe Combinations of Loads.*

(Pounds per square inch.)

Elevation at crown.	Abutment.		Crown.	
	Extrados.	Intrados.	Extrados.	Intrados.
1795...	196	167	98	104
1760...	155	168	80	109
1710...	151	180	80	125
1660...	162	199	84	142
1610...	181	217	93	160
Temperature change	−40 deg. Fah.*	+40 deg. Fah.	+40 deg. Fah.	−40 deg. Fah.
Water load ...	Surface at crown	Reservoir empty	Surface at crown	Reservoir empty

* — means temperature drop.

TABLE III.—*Compression Stresses during Most Severe Combinations of Loads.*

(Pounds per square inch.)

Elevation at crown.	Abutment.		Crown.	
	Extrados.	Intrados.	Extrados.	Intrados.
1795...	222*	306	121*	172
1760...	225*	423	225	266
1710...	345	571	405	356
1660...	434	702	536	418
1610...	491	822	637	465
Temperature change	+40 deg. Fah.	−40 deg. Fah.†	−40 deg. Fah.	+40 deg. Fah.
Water load ...	Reservoir full	Reservoir full	Reservoir full	Reservoir full

* Stress for reservoir empty.

† — means temperature drop.

* Senior Engineer, Technical Investigations, Bureau of Reclamation, Denver, Colorado.

compressive stresses at both extrados and intrados, at both crown and abutment sections, occur during the full condition of the reservoir, except in the case of the abutment extrados stresses in the two upper arches and the crown extrados stress in the top arch, as mentioned above. Maximum compressive stresses at the abutment extrados and crown intrados occur during the assumed temperature rise. Maximum compressive stresses at the abutment intrados and the crown extrados occur during the assumed temperature drop.

Maximum compressive stresses tabulated for the lower arches are probably higher than any that will develop at such elevations, since it is doubtful if the full 40 deg. change in concrete temperature will ever occur at such depths below the full reservoir surface.

Fig. 6 shows the distribution of elemental stresses along the extrados and intrados curves of the inclined arch having a crown elevation of 1710. Since arch properties and loads are symmetrical on the two sides of the crown, only conditions for the left half of the arch are shown. Stresses for full water load include stresses caused by variable water load; but neither full water load nor variable water load stresses include stresses due to concrete weight or to temperature change. Stresses for concrete loads do not include water load or temperature stresses, and stresses for temperature change do not include water load or concrete load stresses. In other words, the stresses shown are the elemental stresses which may be added together to give combined stresses for any desired load conditions. Temperature stress curves are for 40 deg. changes in temperature.

Distributions of water and concrete loads between crown and abutment sections are shown in the upper part of Fig. 6. The concrete load, which is uniform along the inclined arch plane, is divided into two components, one carried by the arch element and the other by the barrel. Both components are uniform along the arch, since the angle of inclination of the barrel with a horizontal plane is constant. The barrel load is carried longitudinally down the barrel to the foundation, causing gradually increasing compressive stresses. The arch component of the concrete load is further resolved into two components which vary with the arch angle. One component acts radially on the arch element, the other acts tangentially. Consequently they are designated radial and tangential concrete loads. Radial concrete loads are a maximum at the crown and zero at the abutment. Tangential concrete loads are zero at the crown and a maximum at the abutment.

Variations of elemental stresses along the extrados are shown in the central diagram of Fig. 6. Variations of elemental stresses along the intrados are shown in the lower diagram. In the case illustrated, full water load causes compression at all positions along both extrados and intrados curves. Variable water load causes tension at the extrados at both crown and abutment locations, and compression at the intrados at both crown and abutment locations, as previously discussed. However, variable water load causes some compression at the extrados, and some tension at the intrados, at locations between the crown and abutments. Concrete load causes compression at the extrados and tension at the intrados, at both crown and abutment locations; also some tension at the extrados and some compression at the intrados, at locations between the crown and abutments, as previously mentioned.

Earthquake Effects

Effects of assumed maximum, horizontal earthquake accelerations equal to one-tenth gravity, having periods of vibration of one second, were calculated for the crown and abutment sections of all inclined arches, for both empty and full conditions of the reservoir; also for the inclined arch with a crown elevation of 1710, for the most severe condition of variable reservoir load. The results of the analyses show that earthquake loads, as would be expected, cause increases in arch stress at all locations, whether the stresses are tension or compression.

During the empty condition of the reservoir, the occurrence of the assumed maximum earthquake shock causes stress increases from about 9 to 14 per cent. of the original stresses. During full reservoir operation, the occurrence of the maximum earthquake shock causes stress increases from about 9 to 39 per cent., the higher percentage increases occurring in the top arch where the non-uniform portion of the water load is more important than the uniform portion. Except for the two upper arches, stress increases due to the assumed earthquake shock during full water load do not exceed 17 per cent. In the case of the most severe condition of variable reservoir load on the arch with a crown elevation of 1710, the occurrence of the assumed earthquake shock causes a stress increase of 18·9 per cent. at the abutment extrados, 21·7 per cent. at the abutment intrados, 22·5 per cent. at the crown extrados, and 27·9 per cent. at the crown intrados. Stress increases at arches below elevation 1710, due to the occurrence of maximum earthquake shocks during the most severe conditions of variable reservoir load, probably are somewhat less than in the arch with a crown elevation of 1710, due to the greater arch thicknesses, the non-uniform loads on the arches being practically the same at all elevations.

Stress analyses for earthquake loads included inertia effects of the concrete in the case of the empty reservoir, and inertia effects of both concrete and water in the case of the full and variable reservoir loads. The analyses for the empty and full conditions of the reservoir were made for inclined arches with rigid abutments, before effects of abutment rotations were included in the calculations. However, analyses based on inclined arches with yielding abutments would show essentially the same stress increases. Abutment yielding was included in the earthquake analyses for the arch with a crown elevation of 1710, for the most severe condition of variable reservoir load.

Effects of Yielding Abutments

Since the multiple-arch barrels of Bartlett Dam have central angles of 180 deg. and are supported by double-wall buttresses, rotations of the abutments due to moment constitute the principal yielding effects which need to be included in the arch analyses. Deflections due to arch thrust simply result in slight downstream movements of the barrels, without causing changes in arch stresses. Tendencies of the abutments of individual multiple-arch barrels to move in cross-stream directions due to water loads are partially balanced by the tendencies of the abutments to move in opposite cross-stream directions due to concrete weight loads, so that resultant movements of the abutments due to total shearing forces are relatively small and can be neglected. Rotations due to shear and deflections due to moment are of a secondary nature and consequently need not be included.

Abutment rotations were calculated by the equation

$$\alpha = \frac{(1-\mu^2)\,Mc}{4\left[1+\frac{c}{2\,(s+t)}\right]E\,I}$$

where α is angular rotation, μ Poisson's ratio, M abutment bending moment, E modulus of elasticity, I moment of inertia, t thickness of buttress walls, s distance between inside faces of the double wall buttresses, and c a distance along the buttress walls chosen to represent the average action of the buttress cross-wall system. Approximate computations, based on the theory of bending of thin plates and the minimum strain-energy principle, showed that the value of c for the Bartlett buttress design should be 100in. Since s has a constant value of 96in., and μ a value of 0·20, the above formula reduces to

$$\alpha = \frac{24\,M}{\left(1+\frac{50}{96+t}\right)E\,I}$$

where all quantities are expressed in pounds and inches and calculated values of α are radians.

Although the inclusion of abutment rotation effects in the arch calculations caused increases in stress at a few locations during certain load conditions, the net results of considering abutment rotations were beneficial. This was particularly true as regards abutment stresses during the most severe combinations of loads. Changes in stress at the crown sections, although usually beneficial, were not of important magnitudes. Maximum tension stresses at the abutment, for the load combinations shown in Table II, were reduced from 17·5 to 19·7 per cent. at the extrados and from 16·8 to 18·2 per cent. at the intrados. Maximum compression stresses at the abutment for the full reservoir and temperature load combinations shown in Table III were not appreciably changed at the extrados, but were reduced from 7·5 to 13·3 per cent. at the intrados.

Due to the excellent quality of the granite formations at the dam site, no appreciable changes in calculated stresses were caused by considering the slight inequalities in rock deformations at the bases of buttresses of different height, located on the sides of the canyon.

Beam Action

Up to the present time beam action has been ignored in designing multiple-arch dams. Water loads have been assumed to be carried entirely by arch action. Designs, properly prepared on such a basis, considering variable as well as full water loads, undoubtedly are satisfactory, since the effects of such beam action as may occur are to reduce the calculated arch stresses without dangerously increasing the barrel stresses. During full reservoir loads, beam action probably is negligible in the greater portion of the barrel. Some beam action probably occurs near the foundation, due to the rigid connection of the base of the barrel with the rock formations; also near the top of the dam, where the non-uniform loads on the inclined arch elements are more important than the uniform loads. Except near the base of the dam, the most pronounced effects of beam action probably occur during the most severe conditions of variable reservoir loading. At such times beam action may transfer appreciable portions of the water load from the arch elements just below the reservoir surface to the relatively stiff unloaded arches just above the reservoir surface, as well as down the vertical elements of the barrel to the rock foundation.

Effects of beam action in multiple-arch dams may be determined by trial load analyses, similar to those made in designing single-arch dams.* In order to study effects of beam action in Bartlett Dam a trial load analysis was made for a reservoir water surface of 1710, 88ft. below normal full reservoir surface. For this condition of loading beam effects were assumed to be negligible above the inclined arch with a crown elevation of 1760 and below the inclined arch with a crown elevation of 1660. In other words, the arch with a crown elevation of 1760 was assumed to have zero deflections, and the arch with a crown elevation of 1660 was assumed to have deflections due to the total combined uniform and non-uniform water loads acting above that inclined plane. In the portion of the barrel between these two inclined arches water loads were divided between the beam and arch elements until calculated radial deflections in the two systems of structural action were equal at all conjugate points. Tangential shear and twist effects were not included in the analyses. However, considering the relatively thin concrete section and the large central angle of the multiple-arch barrel, such effects probably would not change the final results of the study by more than from 5 to 10 per cent. Abutment rotations were included as described in the preceding section. Temperature stresses and the distribution of concrete weight loads between the inclined arches and the vertical sections of the multiple-arch barrel were assumed to be unaffected by the trial load analysis.

The more important results of the trial load analysis are shown on Fig. 7. The total variable water load and its distribution between the arch and beam elements, along the arch with a crown elevation of 1710, are shown in the upper diagram. Effects of beam action on extrados and intrados stresses in the arch with a crown elevation of 1710, the plane of maximum arch effects, are shown in the middle diagram. Beam stresses at the upstream face of the barrel, along the arches with crown elevations of 1710 and 1660, are shown in the lower diagram. Beam stresses at the downstream face of the barrel are numerically equal to those at the upstream face of the barrel, but have opposite algebraic signs. All plotted stresses are due to water load only. They do not include effects of concrete weight or temperature change.

Although beam stresses calculated by the trial load analysis vary in different parts of the barrel, the general tendency is for the stresses to increase at the lower elevations and to reach a maximum value at a situation about half-way between the crown and abutment of the lowest arch included in the analysis. At this position, calculated beam stresses are 28 lb. per square inch tension at the upstream face of the barrel and a numerically equivalent compression at the downstream face. Since the calculated barrel stress at the same position, due to concrete weight only, is 108 lb. per square inch compression, the maximum effect of beam action in transmitting water loads, as determined by the trial load analysis, is to reduce the barrel compression 26 per cent. at the upstream face and to increase the barrel compression 26 per cent. at the downstream face.

* "Trial Load Analyses of Curved Concrete Dams," by Ivan E. Houk, THE ENGINEER, July 5th and 12th, 1935, pages 3 to 5 and 28 to 31.

The curves in the middle diagram of Fig. 7 show that the consideration of beam action reduces arch stresses at nearly all points along both extrados and intrados locations in the inclined arch with a crown elevation of 1710, the plane of maximum arch effects for the assumed condition of reservoir load. Intrados compressions due to water load are reduced 18·3 per cent. at the abutment and 27·9 per cent. at the crown. Extrados tensions are reduced 24·5 per cent. at the abutment and 42·5 per cent. at the crown. Consequently, the results of the trial load analysis for this particular

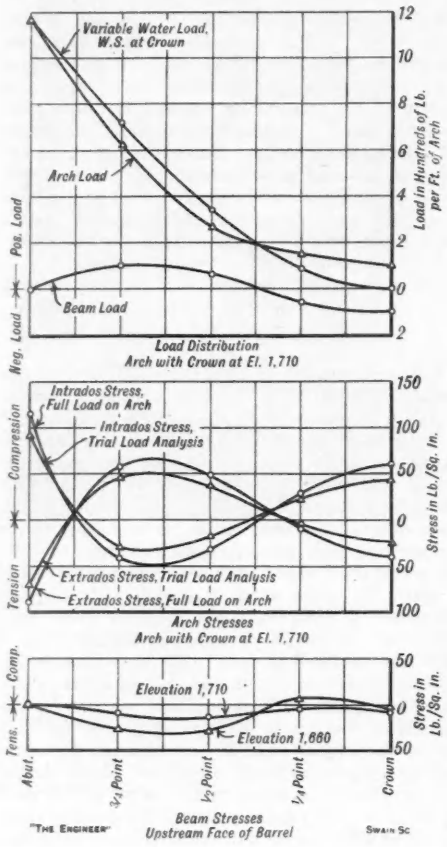


FIG. 7—*Results of Trial Load Analysis, Bartlett Dam*

portion of the barrel indicate that when wave action is ignored, about 75 per cent. of the abutment extrados tension and about 60 per cent. of the crown extrados tension, caused by the most severe condition of variable reservoir loading, should be considered in developing plans for multiple-arch reinforcement. Somewhat different percentages probably would have been obtained if the analysis had been made for a different portion of the barrel. How the percentages vary for portions of the barrel closer to the foundation level, or closer to the top of the dam, can only be determined by additional trial load analyses. Until further data are available, the most conservative practice would be to consider the entire tension forces caused by variable reservoir loading in determining steel reinforcement requirements, especially if no allowances are made for increases in stress caused by wave action.

Conclusions

The foregoing data and discussions lead to the following conclusions regarding critical load conditions and arch stresses in high multiple-arch dams similar to Bartlett dam :—

(1) Variable reservoir loads cause tension stresses at extrados locations at the crown and abutment sections of the inclined arches.

(2) The most critical condition of variable reservoir load is when the water surface is at the crown of the inclined arch being analysed.

(3) Maximum tension stresses at the abutment extrados and the crown intrados occur during maximum temperature drop, the former occurring during the most critical condition of variable water load and the latter during the empty condition of the reservoir.

(4) Maximum tension stresses at the abutment intrados and the crown extrados occur during maximum temperature rise, the former occurring during the empty condition of the reservoir, and the latter during the most critical condition of variable reservoir load.

(5) Except at elevations relatively close to the top of the dam—see Table III—maximum compression stresses at the abutment extrados and crown intrados occur during full reservoir load combined with maximum temperature rise.

(6) In general, maximum compression stresses at the abutment intrados and crown extrados occur during full reservoir load combined with maximum temperature drop—see Table III.

(7) Earthquake loads cause increases in arch stresses at all locations, whether the stresses are tension or compression, the amount of the increase varying primarily with the intensity of the assumed maximum earthquake acceleration.

(8) Abutment rotations which occur with double-wall buttress designs, such as at Bartlett dam, may reduce arch stresses as much as 20 per cent. at the abutment sections.

(9) During variable reservoir loads, beam action may transfer appreciable portions of the water load to the barrel elements and to arch elements above the water surface, causing important stress reductions in the inclined arch element whose crown elevation is at the reservoir surface.

(10) Increases in water surface elevations at the abutments, due to wave action, may cause appreciable increases in stress, along both extrados and intrados curves, the most pronounced effects occurring at the abutment sections of the inclined arch whose crown elevation coincides with the reservoir surface.

(11) Increases in abutment extrados tension caused by wave action during variable reservoir loads approximately balance the stress reductions caused by beam action.

Acknowledgments

The final stress studies for Bartlett dam were made by F. D. Kirn and S. D. Larson, under the direction of the writer. Technical investigations connected with the design of dams are carried on under the general supervision of J. L. Savage, chief designing engineer. All engineering and construction projects of the Bureau of Reclamation are under the supervision of R. F. Walter, chief engineer, with headquarters at Denver, Colorado ; and all activities of the Bureau are under the general supervision of John C. Page, Commissioner, with headquarters at Washington, D.C.

The Measurement of Engine Power during Flight

(By Our Aeronautical Correspondent)

LET it be admitted at once that the average aeronautical engineer would say, were he asked, that he knew of no really successful means of measuring the power of an aero-engine during flight. That does not mean that many very promising attempts have not been made, nor that some of them may not attain success. Indeed, one does occasionally hear claims made of the attainment of entire success in solving the problem, though they are not yet generally admitted. It is interesting to consider how this situation has arisen.

The corresponding problem in the earlier means of transport was to measure the power exerted by locomotives, whether steam, electric, or otherwise. On the whole, they were not so very difficult to deal with, and especially was this so in the case of the electric locomotive in which the electric meters normally fitted give the desired elements of information almost at once, and the resulting calculation is the simplest. Even in this case, what one gets is the power input, corresponding to the indicated horse-power of a steam engine, but since the mechanical efficiency of the electric motors is sure to be well known already, the brake horse-power is readily determined, and there is no need to go to the complication of fitting a torque dynamometer, although, as it happens, it would be easy to apply one, since the torque given by electric motors is attractively steady. With the steam locomotive, it was possible to take indicator diagrams from each of the cylinders and so get the total indicated power, but this was not commonly done. Nor was it a simple alternative to fit any form of torque dynamometer to a locomotive—indeed, with the complication of coupled wheels it would be a matter for scientific research rather than for ordinary testing procedure. To obtain the brake power, or at any rate its equivalent, it is best to use a dynamometer car in which the tractive force of the engine can be measured by what may be called steelyard methods, or alternatively by the deceleration of the train when the power is cut off. As is well known, an accelerometer instrument under the latter conditions will give a direct reading of the tractive resistance in pounds per ton. All that is needed is that the plane of the instrument shall be kept parallel to the plane of the track, but this usually presents no serious difficulty. When engine power is applied the reading gives the tractive effort of the engine less the resistance due to road and air. All this can be done also on an electric train, but for the reasons above cited the desired information can then be obtained in simpler ways.

The case of the automobile is very generally similar to that of the steam locomotive, except that the indicated power is far more difficult to measure because of the multiplicity of cylinders, and because of the high speed of rotation which makes it impossible to use a simple form of indicator, such as would be satisfactory on a steam engine ; on the other hand, it would be fairly simple, if it were so desired, to fit a torque dynamometer to the propeller shaft, although the very considerable and rapid changes in the value of the torque would have to be allowed for in the mechanical arrangements. In practice, however, the custom is to make use of a test house containing a road wheel dynamometer in which the car is mounted on a rotating track, whilst itself stationary. It is then a simple procedure to fit a brake, and so measure the power given at the road wheels. Furthermore, it is possible with motor cars—indeed, easy—to use the accelerometer method during a test run on the road.

So when we come to the question of how to measure the power of an aero-engine, the first action is naturally to see how far any one of the methods used in the older forms of locomotion can be adapted to the new purpose. One must rule out the mere brake testing of the engine by itself. It is the engine in position in the aeroplane, with all the disadvantages of that situation, that must be the object of attack. As in the case of the motor car, the use of an indicator is almost out of the question—even more so as there will usually be at least twice as many cylinders. The use of a torque dynamometer presents grave difficulty because the length of shaft between the engine and the tractor air screw is almost negligible in extent.

As may well happen in the future, when the use of pusher air screws becomes common, the problem of torque measurement will be simpler, but at present it is far from being so. With pusher air screws it will still be necessary, because of centre of gravity requirements for the whole aircraft, for the engine masses to be kept well forward in the aeroplane ; hence a considerable length of shaft from engine to airscrew will have to be provided, and this will make things simpler for the fitting of a torque dynamometer. With the normal tractor air screws, however, the problem is a very difficult one. Nor is the accelerometer method nearly as easy to apply as on the road, since the tilt of the centre line of the aeroplane changes with every manœuvre, and there is even with the change of atmospheric density due to change of altitude a corresponding change in the angle of attack of the wings. Change in atmospheric pressure will also alter the engine power, and this may call for some alteration by the pilot in the conditions of supercharge or boost in which the engine is run. But any change in the fore-and-aft level in the aircraft changes the component of gravity resolved along that line, and will therefore affect the reading of any inertia-operated instrument. It is true that by suitable gyrostatic means this could be corrected, but by the time this had been effected the instrument would have become so complex as to be almost unworkable. Such methods, though theoretically practicable, are, in fact, not used. Reliance is commonly placed instead on the brake power of the engine as measured in the test house by itself, or upon the supposedly known characteristics of the air screw used, or upon the readings of an air flow meter combined with a

knowledge of the air used per horse-power, or in the last alternative by the use of some form of torque dynamometer designed for the purpose.

The great obstacle to be overcome in the use of a torque dynamometer is shortness of the length of shaft available for the purpose, and the exceeding irregularity of the torque to be measured. There may in a single engine be twenty or more cylinders, each producing, on a four-stroke cycle, an exceedingly peaked pressure curve, and the more steeply peaked as higher compressions with special fuels come more and more into use. The position is well stated by Dr. D. R. Pye, in his book on the internal combustion engine, that the production of a reliable instrument for measuring engine torque in the air is a matter of much difficulty, although with special precautions it is possible to obtain consistent readings.

It is hardly necessary in these days to describe the usual form taken by a torque dynamometer, but something needs to be said of the variation necessary in its design to fit the special needs of an aero-engine. In all quantitative work in aircraft one needs sensitive, but very foolproof instruments, and it fortunately happens that there are available in these days some exceedingly sensitive means of measurement of relative twist even on so very short a length as is here presented. These depend on electrical measurements. Probably the one that combines the highest degree of sensitiveness with the greatest facility of use is the induction balance method. In this the two parts of the shaft, whose change of relative angular position due to the torque it is desired to measure, are each made to carry one half of an electro-magnet in such a way that the air gap between the two halves of the magnet changes with the twist. Small as is the amount of the change, it is quite enough to affect appreciably the self-induction, and hence the current flowing under an applied alternating electric potential. If now we have a second such electro-magnet, with a micrometer air gap to which the same potential can be applied, we can by means of the micrometer adjust the air gap until the currents in the two circuits are exactly equal and opposite (a null method is always a sensitive one). When that is achieved we know that the air gaps must also be the same, and the micrometer reading therefore must give the amount of the twist that has taken place. The elastic coefficients being known, the torque is in this way measured. This reading, combined with the rate of rotation given by the revolution indicator, permits the power to be computed.

The elastic element whose twist it is desired to measure in this way need not necessarily be the shaft itself; in fact, it may be convenient to insert between the shaft and the air screw a specially constructed spring wheel and to use the electrical means above described to measure the relative twist of hub and rim. An attack on the problem on these lines was begun at the Royal Aircraft Establishment some nine years ago, and after much work, a report on the results attained was made to the Royal Aeronautical Society in 1937 by Mr. N. S. Muir. The form of spring wheel eventually chosen was one having twenty-four double cantilever radial arms connecting boss and rim, the whole being machined from a solid steel forging. This particular hub, as used in flight, weighed 107 lb., or with the air screw 167 lb., compared with the normal hub alone, which weighed 32 lb. As a result of these tests it was concluded that the apparatus gave consistent and reasonably accurate results, and that if a new instrument were constructed to embody improvements in detail, an accuracy in torque readings within 1 per cent. should result.

It happens, however, that the coming of the variable pitch air screw provides another means whereby torque can be measured. In a common form of this air screw, the blades are rotated in their sockets to the desired pitch angle by means of small cylinders hydraulically operated. Once oil pressure is made available at the air screw hub, it is possible so to arrange the latter that the torque transmitted to the blades shall be balanced by oil pressure, and in that case a pressure gauge at once gives a measure of the torque. Some success on these lines is already reported.

It may be asked whether there is no method which would be applicable to aircraft similar to the measurement of the draw-bar pull of a locomotive. Such a method would involve measuring the pull exerted by a tractor air screw, or the push given by a pusher; in either case it requires that the longitudinal force in the shaft between air screw and engine should be measured. This, as it happens, is an exceedingly difficult thing to do. It has been attempted by measuring the thrust on the engine bearers, treating engine and air screw as one. But such plans cut across the rather precise methods of engine mounting and though possible in theory, have not been distinguished by success in practice. Hence the measurement of torque rather than thrust is the better channel by which to proceed, and by that path a certain degree of success has already been found to be attainable.

The Centenary Royal Show at Windsor

No. II

(*Continued from page 12, July 7th*)

THE Centenary Show of the Royal Agricultural Society of England, which closed on Saturday, July 8th, will long be remembered. On Wednesday and Friday the Society welcomed its Royal President, and the King and Queen were loyally greeted by the many thousands who attended the Show on those days. On Wednesday one of the first acts of His Majesty was to confer the honour of K.C.V.O. on Mr. Roland U. Burke, the Honorary Director of the Show, who, beginning as an assistant steward, has been closely associated with the arrangement and carrying through of Royal Shows for the past forty-three years. On Wednesday evening the King gave a dinner party at Windsor Castle, to which over one hundred guests, who represented all the different branches of British agriculture, were invited. In the course of a short speech made during the evening His Majesty expressed the hope that the historic occasion of that evening would mark the beginning of a new era during which agriculture would come to its own. On Friday the King, who was accompanied by the Queen and the Princesses, again visited the Show, and during the afternoon inspected a number of stands. He took particular interest in examples of ploughs, made over one hundred years ago, which are still in use, and in a number of other historical exhibits.

As befitted the occasion, the historical aspect of the Centenary was reflected by some of the machinery shown on the stands of the various firms. From a general point of view, however, the houses, farms, and equipment of a hundred years ago were effectively contrasted with those of to-day in a special exhibit consisting of an old farmhouse and a set of farm buildings in which has been housed a collection of contemporary farm implements, prepared by the Colchester and Essex Museum. Near this old farm there was a model farm and farmhouse of to-day, which has been equipped with the latest electrical appliances. Another historical collection was that of carriages and road vehicles, which were horsed from His Majesty's stables and took their part in a grand parade. A special educational exhibit was arranged by the University of Reading in collaboration with the Ministry of Agriculture, and in connection with this exhibit some of the latest films dealing with research and progress in agriculture were shown.

R. A. LISTER AND CO., LTD.

In a model which was shown on the stand of R. A. Lister and Co., Ltd., of Dursley, Gloucestershire, an attempt was made to depict the farm of the future and to illustrate the use of fully mechanical methods in agriculture. The model was designed by Mr. H. Warren Wilson, Lecturer in Decoration at University College, University of London, and was built on lines suggested by Mr. S. L. Bensusan, the writer on agricultural subjects, who has collaborated with Professor Charles. S. Orwin, Director of the Institute of Research in Agricultural Economics at the University of Oxford, and Principal J. C. Leslie, of the East Anglia School of Agriculture. The model covers an area of about 300 square feet, and represents an acreage of approximately 2700. The farm of the future, according to it, will consist of a town-planned middle section of four large farms, with a factory or mechanical centre, which will probably include a power-house, a sugar beet factory, a cheese factory, a cannery, an abattoir, and a bacon factory, as well as a bakery and machine sheds and repair shops. The fruit farm has its own small flying field and a cold storage plant, slow-flying rotating-wing

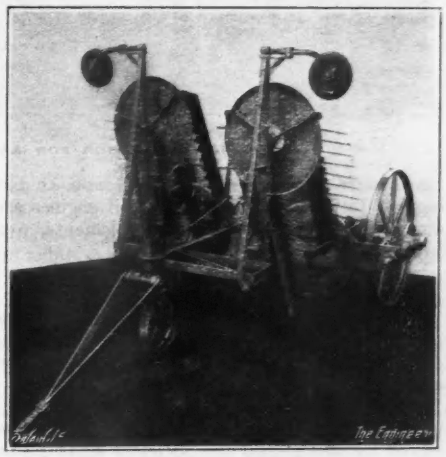
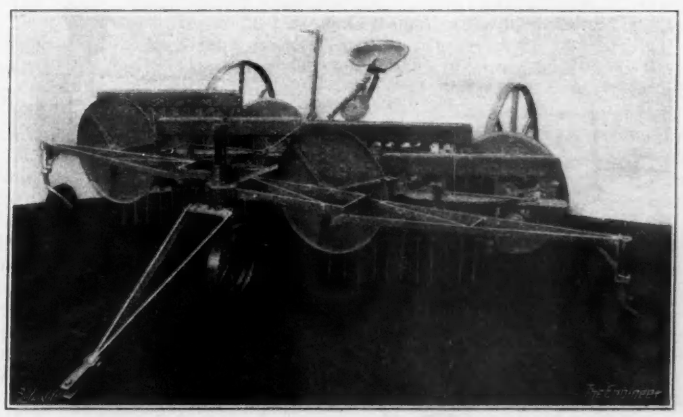
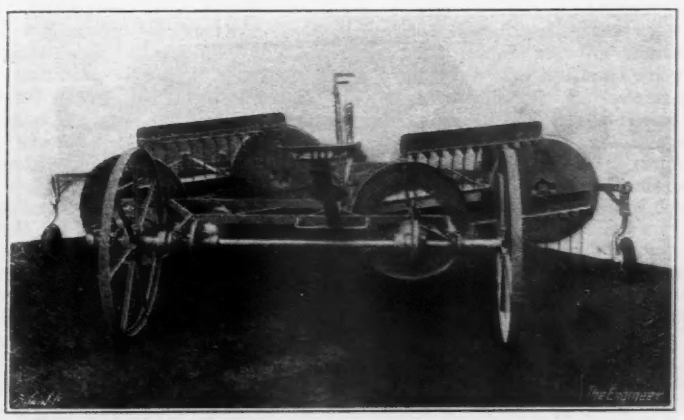


FIG. 13—HAYMAKING MACHINE FOLDED—NICHOLSON





FIGS. 11 AND 12—HAYMAKING MACHINE SET UP FOR SWATH-TURNING AND COLLECTING—NICHOLSON

gyroplanes being employed for spraying and soil dusting.

The model seeks to emphasise the need for ordered planning, so that the land can be made to produce the crops for which it is best fitted; adequate housing in relation to both the work on the farms and in the factories; and the grouping of farms in relation to the all-important factory unit. The model was offered by its designers and Messrs. Lister as a contribution to the discussion of the future of the farming industry. On the stand a full range of Lister products, such as oil engines and dairy and farm apparatus and implements, were shown.

W. N. Nicholson and Sons, Ltd.

From the wide range of cultivating and harvesting machinery shown by W. N. Nicholson and Sons, Ltd., of Trent Ironworks, Newark-on-Trent, we have chosen for illustration—see Figs. 11 to 13—a new haymaking machine for turning and collecting the swaths cut by a 6ft. mower, which was entered for and gained the Society's silver medal. The design is particularly interesting, as it provides for two settings, one for turning the whole swath and the other for collecting the turned swath by raking it into one row, where in a light condition it is ready for sweeping or picking up by a hay loader. The two settings are illustrated by the engravings reproduced herewith. In addition, the machine has been made so that, although it is designed to clear 12ft. of ground at one passing, it can be folded up without dismantling any part, so that it can pass easily through a 9ft. gateway. The main framework is articulated and the various parts of the turning heads are guided by rubber-tyred castor wheels so that they follow uneven ground closely. Special attention has been paid to the design of tine bars adopted, so that when changing from swath turning to collecting there is no need to use a spanner, four star bronze nuts being provided, which can be easily hand tightened. The threads of the nuts are relieved for a short distance to make the starting of the thread easy. These nuts will be seen in the foreground of Fig. 11. The tine bars can be quickly removed from the heads and reassembled with their discs in alternative positions, for which duplicate axles are arranged, one set of axles serving for the swath turning position, shown in Fig. 11, and the other for the collecting position, shown in Fig. 12. The tine bars, we noted, are made specially wide, so that the heads of the swaths are moved, which are generally pressed into the ground by the tractor wheel passing over them. In the collecting position the actual clearance below the raking tines is larger than when in the swath turning position, and collected swaths have plenty of room to pass through. The gear-boxes have roller bearings and the machine, which is light to pull, can be supplied either for horse or for tractor draught.

A greatly improved machine for distributing artificial fertilisers, which is illustrated in Fig. 14, was also shown. With standard equipment it can be set to give feeds from 29 lb. up to 3000 lb.

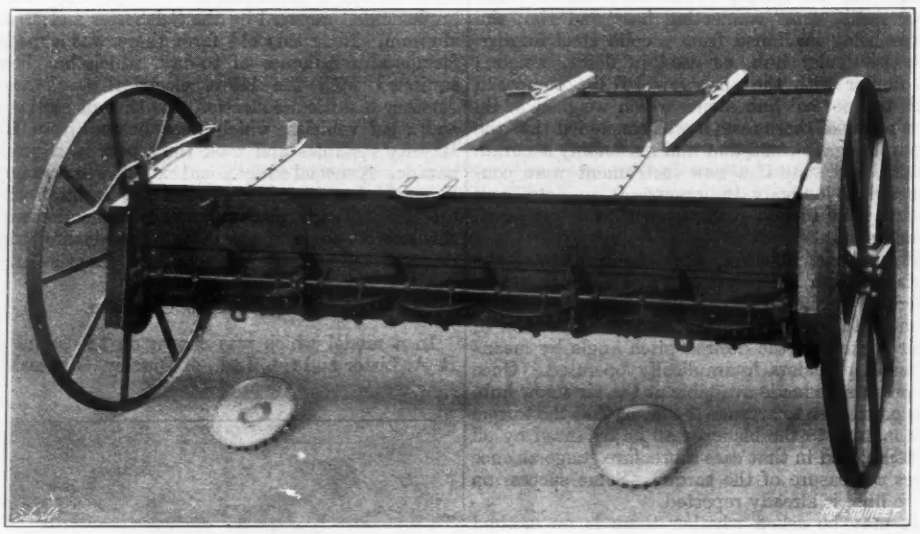


FIG. 14—DISTRIBUTOR FOR ARTIFICIAL FERTILISERS—NICHOLSON

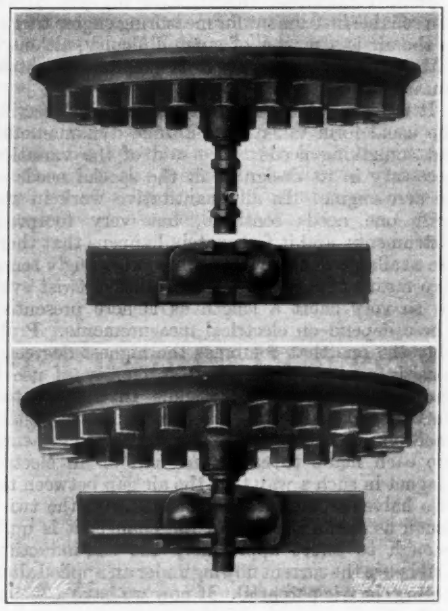


FIG. 15—FEED DISC MOUNTING—NICHOLSON

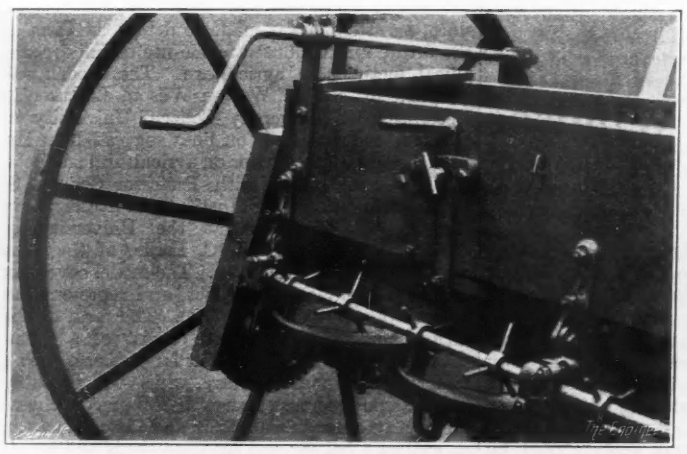


FIG. 16—DISTRIBUTOR DRIVING GEARS—NICHOLSON

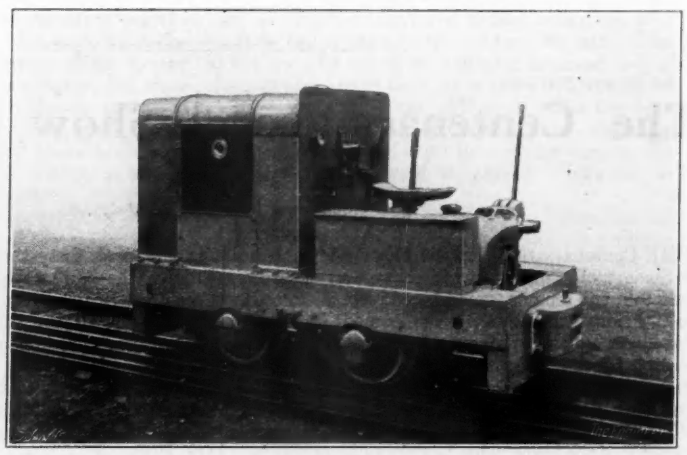


FIG. 17—OIL-ENGINED LOCOMOTIVE—RUSTON

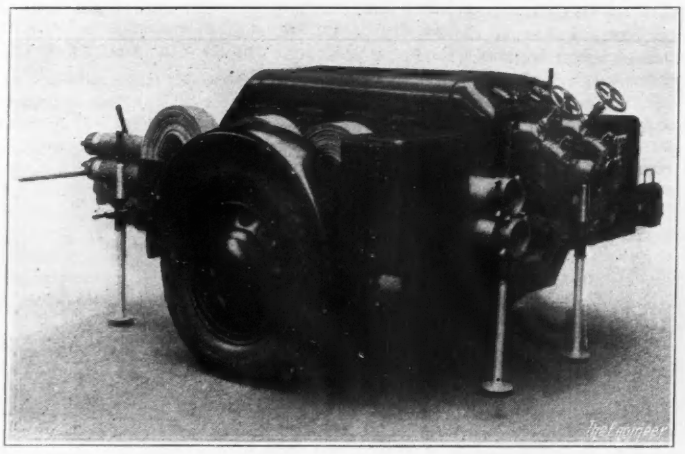


FIG. 18—LARGE TRAILER FIRE PUMP—BERESFORD

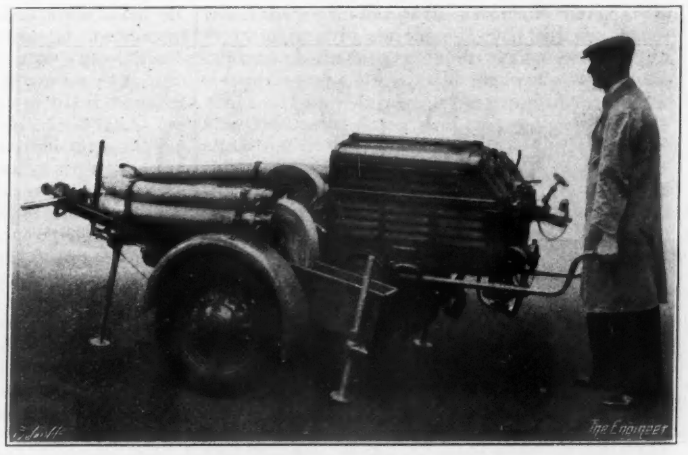


FIG. 19—SMALL FIRE PUMP—BERESFORD

of fertiliser per acre without changing screens and with no extra parts. The main feature of the new design is the self-cleaning character of the machine. As will be seen from the accompanying engraving, Fig. 15, the feed discs are quickly removable without using a spanner. The arrangement is particularly advantageous in the case of nitrates and other manures which tend to set hard, as it permits the machine to be thoroughly cleaned, and increased accessibility is given to the hopper when the feed discs have been removed. The gearing, which is below the feed disc, is without a shroud and the wheel with which it meshes has the roots of the teeth chamfered back so that no fertiliser dust can accumulate therein. The driving gears at the end—see Fig. 16—are all enclosed in a dustproof casing. All bearings are made dustproof and are furnished with Tecalemit

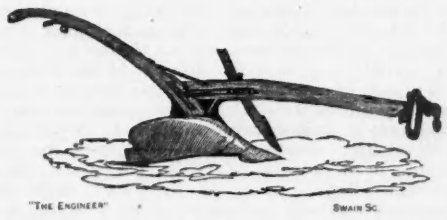


FIG. 20—OLD SUFFOLK SWING PLOUGH—RANSOMES

grease gun lubrication. As we show by our illustration (Fig. 16) the feed mechanism and all the bearings are arranged outside the feed hopper; the feed setting lever is locked by a strong T nut. A refinement is the provision for tilting the hopper by means of a simple transverse screw, so that it remains upright even when working on inclined ground. By the simple arrangement of two sets of bearings the travelling wheels can be worked in two positions, to set the distributor plate close to the ground for broadcasting or well up to clear the tops of the ridges when sowing drills. By using wind boards fertilisers can be evenly laid on windy days, while when drill sowing the extra clearance given by the higher axle position allows the fertiliser to be put exactly where it is wanted in the drills.

Other exhibits included a 4ft. by 1ft. 9in. riveted boiler with its pumps and fittings, and a series of the firm's special corn and cake mills. It is of interest to record in this connection that the late Mr. W. N. Nicholson was awarded a silver medal for a power cake mill, which was on view at the Show of 1847, ninety-two years ago.

JAMES BERESFORD AND SONS, LTD.

In order to show the exceptional suction lift which can be obtained with the Beresford-Stork patented centrifugal self-priming pump, James Beresford and Sons, Ltd., of Saltley, Birmingham, displayed a pump mounted on the top of a 27ft. tower. By means of an electrical time switch the pump was run for half a minute and then stopped for one-third of a minute. On restarting the water was seen to rise in glass suction piping and feed through the funnel on the delivery side of the pump in eight to twelve seconds. By lifting the suction rose half out of the water, a mixture of air and water was handled. Several types of pumps for shallow well duty were on view, and on one of them the Beresford-Stork automatic pressure system was demonstrated. Water raised from a well is delivered into a pressure tank charged with air pressure. As the amount of water in the tank increases the air pressure is increased up to, say, 45 lb. per square inch. When this pressure has been reached the motor driving the pump is cut out by means of a pressure switch mounted on the tank, but the water supply can be maintained under pressure until it falls to about 21 lb. per square inch, when the motor is again automatically started. Plants designed for household, farm, and town and industrial supplies were shown.

Particular interest, however, attached to two Beresford-Stork trailer fire-fighting pumping sets, which are illustrated in Figs. 18 and 19, and have been supplied by the firm to the Government to Home Office requirements. The smaller set is equipped with an Austin "Eight" petrol engine, while the larger set has a Ford "V 8" petrol engine. Points in design include the provision made in the case of the smaller pump for taking the pump unit with its engine off the trailing carriage. The unit is fitted with small wheels and can be taken into narrow spaces, where the larger width of trailer could not go. Both sets are fitted with the firm's patented exhaust vacuum primer, which at the National Physical Laboratory has shown that the pump can be primed in seventeen seconds five hundred consecutive times, at the specified positional lift of 24ft. In accordance with marine practice the oil pumps of the engines are water cooled.

For deep wells and bore-holes from 6in. diameter the firm supplies Beresford-Garvens submersible pumps; they were exhibited from the smallest, driven by a $\frac{1}{2}$ H.P. motor suitable for a 6in. bore-hole, to the largest driven by a 60 H.P. motor, designed for use with a 12in. bore-hole. This type of pump can also be supplied with the pressure tank referred to above.

RUSTON AND HORNSBY, LTD.

The stand of Ruston and Hornsby, Ltd., of Lincoln, was noteworthy for the wide range of oil engines, designed for heavy-oil fuel, paraffin, and petrol fuels. Many of the engines were shown in actual operation. They included vertical, single, and twin-cylinder engines of from $3\frac{1}{4}$ to 11 B.H.P., and two horizontal engines of 6 and 20 B.H.P., respectively. The range of engines utilising paraffin fuels included models of the "A P" and "B P" patterns, with designed outputs of 4 to 10 B.H.P., and 3 to $6\frac{1}{2}$ B.H.P. respectively. The small petrol engines included the $1\frac{1}{2}$ to 2 B.H.P. horizontal and the $1\frac{1}{2}$ to $2\frac{1}{4}$ B.H.P. vertical engine, which are generally similar in design, with fuel and oil tanks designed for a normal day's run for such work as driving elevators and milking machines. There was also on view a $\frac{3}{4}$-kW, 110-volt lighting set, comprising a $1\frac{1}{2}$ B.H.P. petrol engine, coupled to the generator by means of a V belt, which forms a part of a range of units specially designed for A.R.P. work. A new exhibit, which we illustrate in Fig. 17, is the 10 to 13 H.P. Ruston locomotive, which is equipped with a single-cylinder Ruston heavy oil engine, and in general design is similar in equipment to the larger sizes of locomotives used for contracting and quarry work. This model, which can be run on an easily laid light track, is recommended for the convenient handling of large farm crops, such as sugar beet and potatoes. It is fitted with a two-speed constant-mesh gear-box, and the gears are exceptionally easy to handle, since changing from one speed to another is effected by merely moving a lever out of one slot in the change-speed gate into another slot, no foot action being required. Further, this locomotive can be controlled by a man walking alongside the machine, a provision which is particularly useful when shunting or coupling up.

The larger range of locomotives was represented by a 16 to 20 B.H.P. model, and this series includes special locomotives for underground work, which, when called upon to work in gassy mines, can be provided with a patented exhaust filter and a flame trap.

RANSOMES, SIMS AND JEFFERIES, LTD.

Probably the largest exhibit of farming implements at the Show was that arranged by Ransomes, Sims and Jefferies, Ltd., of Orwell Works, Ipswich,

FIG. 22—BUDDING'S MOWER OF 1830—RANSOMES

which is the only surviving firm of manufacturers who exhibited implements at the first Royal Show of 1839. A special feature of the implement stand was a section devoted to actual ploughs made before 1839, which have been in use ever since. There were also other records and photographs relating to Ransomes' connection with the early Royal Shows and the agricultural community generally. From these early exhibits we have chosen for illustration (Fig. 20) the Suffolk swing plough,

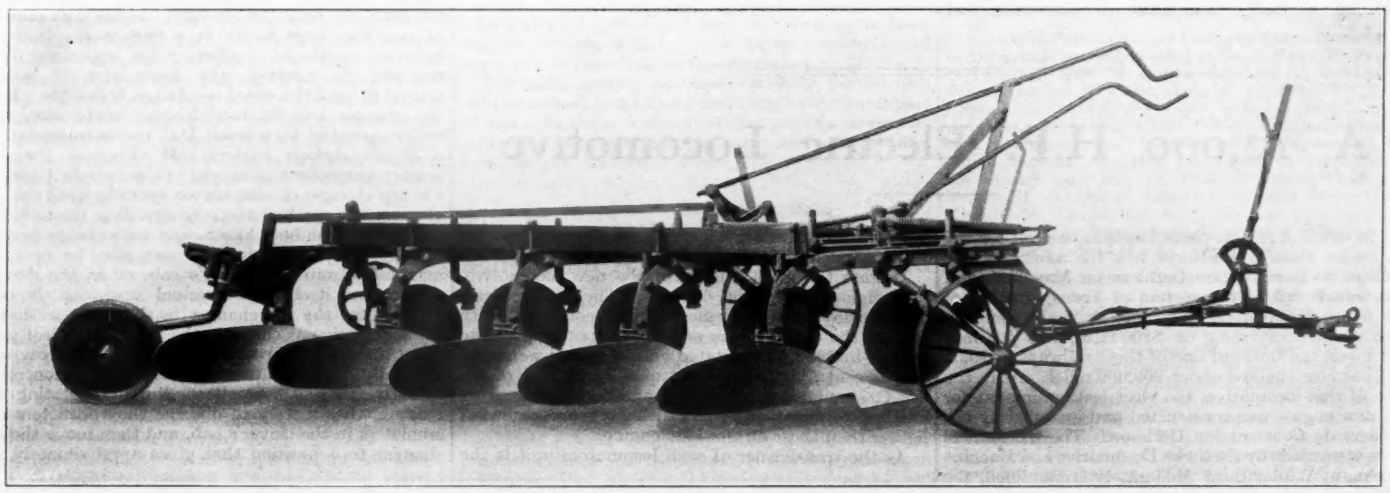


FIG. 21—FIVE-FURROW SELF-LIFTING TRACTOR PLOUGH—RANSOMES

which, except as regards the beam and the draught irons, is similar in design and construction to the Suffolk wheel plough in Suffolk and the counties adjoining it. Another interesting historical plough was the Rutland plough, which took its name from the county to which it was introduced by Richard Westbrook Baker, of Cottesmore, for whom it was in the first instance expressly made on a simple plan suggested to Messrs. J. R. and A. Ransome by Mr. Baker. Afterwards it found a wider field in general use.

As a contrast to these old ploughs, which in their design and workmanship pay a silent tribute to the implement makers of bygone days, we show in Fig. 21 an up-to-date five-furrow self-lift tractor plough, known as the Ransome No. 3 "Quintrac." It has a designed output of five furrows, $8\frac{1}{2}$in., $9\frac{1}{2}$in. or $10\frac{1}{2}$in. wide by 9in. deep, and with its self-lifting attachment it forms a one-man outfit with the tractor.

Some other exhibits included horse and

tractor ploughs, and tractor cultivating implements, among which we noted some ploughs and harrows built to the original design of the late firm of Howards, of Bedford.

There were also Hornsby ploughs, now manufactured by Ransomes, Sims and Jefferies, and a heavy threshing machine, which has ball bearings throughout; also a hay trusser, built by the associated firm of Ruston and Hornsby, Ltd., of Grantham. In addition, a model crop dryer was on view, and a selection of ploughs and cultivating implements, specially designed to meet the requirements of the export market.

As well as the general implement stand above referred to, there was also a special display of Ransome lawn mowers near the Horse Ring in the centre of the showground. An item of historical interest on this stand was the original lawn mower of the roller pattern which was made by the firm, to Budding's patent, as long ago as 1832. It is now in the Science Museum at South Kensington, and was lent for the Royal Show. It may be recalled that about 1830 Edwin Budding, of Stroud, had invented and patented a machine for cutting grass in the same way as the nap was shorn from the cloth in the factory in which Budding worked. The firm of Ransome had obtained at an early date a licence to manufacture the machine under royalty, and we illustrate in Fig. 22 one of these first machines with its grass box. In great contrast, stand the motor, electric, and hand machines of to-day, which, however, still retain in their design and construction many of the original principles of the first Budding's machine. As a typical example of the most modern construction, we illustrate in Fig. 23 the "Certes" ball-bearing mower specially designed for the cutting of bowling and golf greens. It is precision made, with die cast aluminium frames, and an easily removable aluminium back roller, all the bearings being dustproof and fitted with self-aligning ball bearings. In the back roller there is a patented double free-wheel drive, and all the working parts have oil gun lubrication. The cutting cylinder consists of a welded unit, with eight or ten crucible steel blades, while the bottom blade is made specially thin for close cutting. The adjustment is given by a single screw on the front roller, with a patented compensating device, which operate both ends at once, and ensures accurate adjustment. Light rubber transporting wheels are supplied with the machine.

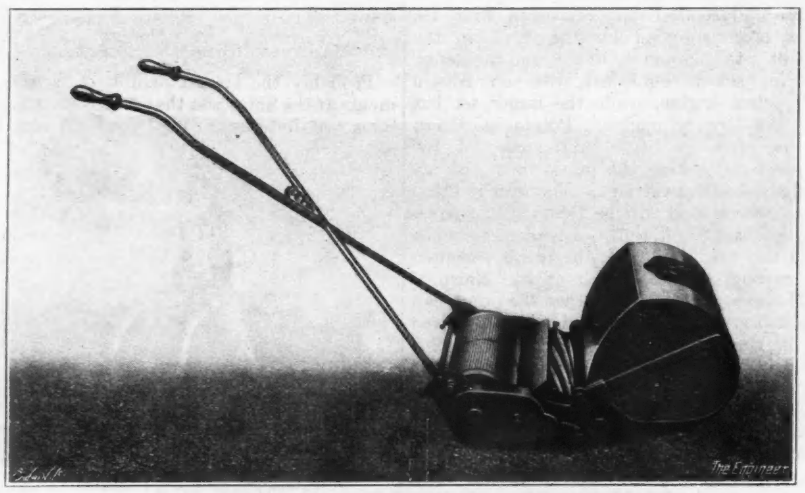


FIG. 23—MOWER FOR GOLF AND BOWLING GREENS—RANSOMES

(To be continued)

A 12,000 H.P. Electric Locomotive

A 12,000 H.P. single-phase locomotive built for the Swiss Federal Railways left the works of the Ateliers de Construction Oerlikon on May 2nd, and was transferred to the section of Transportation of the Swiss National Exhibition. A similar engine, with a one-hour rating of 8800 H.P., was put into service on the Gothard line of these railways in 1932, and has now covered about 600,000 miles. As in the case of this locomotive, the electrical equipment for the new engine was constructed and installed by the Ateliers de Construction Oerlikon. The mechanical parts were made by the Swiss Locomotive and Machine Works, of Winterthur. Moderately streamlined, the new locomotive presents a pleasing appearance, especially as two pantograph current collectors are used, instead of four on the engine put into service in 1932. The high power of the locomotive necessitated building it in two units, articulated by a special short coupling. During normal service the units are tightly coupled, but they can be easily separated for inspection and repair. As the locomotive is to be used on the Gothard line, where long gradients of 1 in 37 are encountered, the Oerlikon Company's single-phase system of electric regeneration is employed.

There are eight driving axles, each loaded to the extent of 44,000 lb. to develop the starting tractive effort prescribed by the railway administration. In the case of bad rail conditions or during exceptionally heavy starts, an electro-pneumatically operated load-shifting device enables the driver to increase the load on the driving axles to 47,500 lb. The pressure on the overhead line is 15 kV and the frequency $16\frac{2}{3}$ cycles. Measured over the buffers, the length of the engine is 111ft. $6\frac{3}{4}$in.; the total wheel base, 95ft. $7\frac{7}{8}$in.; whilst the wheel base of one unit is 41ft. $\frac{3}{16}$in.; the diameter of the driving wheels is $53\frac{3}{8}$in.; and that of the guiding wheels, $37\frac{3}{8}$in. There are sixteen traction motors, driving trough double reduction gears with a ratio of 1 to 3·47. The maximum speed is 68 m.p.h. Two transformers are each capable of giving a continuous output of 7300 kVA.

Despite the great output of the new locomotive, its weight is only 256·65 tons. The 26 per cent. increase in the transformer output, compared with that of the transformers on the locomotive put into service in 1932, necessitated an increase in weight of 15 per cent., but on account of the adoption of the J.E.C. standards for the determination of the rating and improvements in design, the motors are somewhat lighter than those on the 1932 engine.

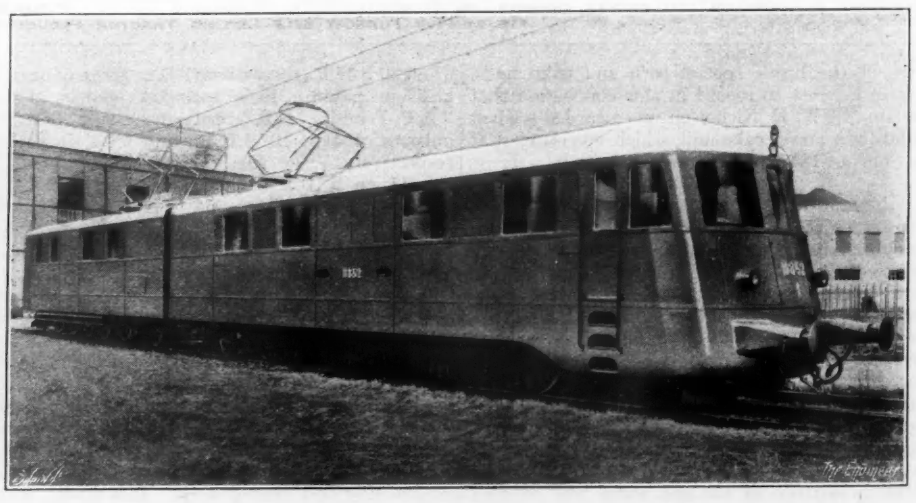
As the transformer of each locomotive unit is the heaviest unit it is placed in the middle on the running gear. Power from the railway motors to the driving axles is transmitted through the Swiss Locomotive and Machine Works universal double-reduction individual axle drive, which necessitates placing two series-connected motors crosswise above each axle within the locomotive. Two motors are cooled by a common ventilating group, which also cools the transformer oil. Four fan groups are provided for each locomotive unit.

At one end of each of the locomotive units is a spacious driver's compartment, from which the two locomotive units, although electrically independent of each other, are controlled. Each driver's compartment contains a master controller, measuring instruments, and the brake valves necessary for safe operation. On the driver's desk are also various measuring instruments and control apparatus. The electric and pneumatic measuring instruments are neatly arranged in front of the master controller.

A high-voltage control system recently developed by the Oerlikon Company is used for speed regulation. The only low-tension switchgear in the motor compartment are the reversers and an electro-pneumatic unit switch for each motor group. At the extreme end of each locomotive unit is the switchboard for the auxiliary circuits and the locomotive protecting relays. Each unit is equipped with an air brake compressor with an approximate capacity of 82 cubic feet per minute at a pressure of 115 lb. per square inch. A high-voltage breaker is in circuit with the pantograph current collectors on the roof, and disconnecting knife switches and a two-pole earthing switch allow either of the pantograph or transformers to be cut out at will.

The transformer unit on each section of the locomotive really consists of one regulating and two secondary transformers, all in a common oil tank, but the high-tension tap changer is in a separate tank, the design of the entire transformer group and the tap changer being such that all high voltage connections are inside the tanks. The two tap changers connected to each transformer set are alternatively operated by a special drive mechanism, and supply the secondary transformers with voltages taken from the taps of the regulating transformer in such a way that a total of twenty-nine running steps are obtained with only half this number of taps on the regulating transformer. On the low-tension side the two secondary transformers are permanently connected in series. All the transformers are cooled by oil pumped through air-cooled radiators.

Each tap changer is composed of two plate selectors, with the contacts arranged in a circle, and to ensure smooth transfer from one tap to another, a resistance is introduced into the circuit during the transfer period. To prevent the contact arms interrupting the current, four cam-operated arcing contacts are built into each tap changer. As the high number of running steps result in a comparatively small increase in tractive effort, when switching from one step to another, the locomotive is started smoothly, and the speed regulation is flexible. Each tap changer has its own driving mechanism, normally operated by a small D.C. motor connected to a 36-volt storage battery. If either of the two master controllers is moved to a certain position, the tap changer driving motor operates until the tap changer has reached the corresponding position, the tap changers on both locomotive units always moving in step. The tap changers can also be operated manually, from the driver's cab, or at the driving mechanism itself, but manual operation is only possible for the tap changer in the same section of the locomotive as contains the manual control gear. Nevertheless, it is possible to operate the rear unit manually, while the front unit is remotely controlled from its master controller. A man operating the rear unit has merely to observe the voltmeters and ammeters in the driver's cab, and then move the tap changer to a position that gives approximately the



ELECTRIC LOCOMOTIVE FOR SWISS FEDERAL RAILWAYS

same voltage and current as shown by the instruments for the other unit.

The traction motors are compensated single-phase commutator machines, with phase displaced commutating pole fields. Motor-driven fans on top of the traction motors provide the ventilation. On removing the cover of the traction motors, the commutator and brush gear become accessible. A rotating brush rocker enables the brushes to be inspected, including those normally situated in the lower part of the motor. Mechanically heavy stressed parts, such as bearing shields and armature spiders, are made of cast steel, but wherever possible aluminium alloys are employed. For the insulation of the commutator and windings, mica is used. To suppress the higher harmonics, the armature slots are slanted to the extent of one pole patch. Two motors for a driving axle are permanently connected in series for motoring and regeneration.

Four such motor groups for each half of the locomotive are permanently connected in parallel, and each group has an electro-pneumatically operated unit switch, which closes the motor circuit each time the master controller is moved from the zero to the first operating position, and opens again when the controller is again moved to the zero position. Each motor group also has a reversing electro-pneumatically operated regenerating changeover switch, which never interrupts the power. The traction motor circuits are earthed by a protecting resistance in such a way that the highest service voltage in any part of this circuit is never more than the voltage of one motor, *i.e.*, about 450 volts. For testing the insulation of the traction motor circuits, there is an ammeter connected up by a push-button switch and a limiting resistance protects the instrument in the event of a direct earth connection. To cut out one of the traction motor groups it is only necessary to interrupt the control circuit of its pneumatic unit switch.

The fan group of each of the two motors is operated by a 17 H.P., 220-volt, 2000 r.p.m., single-phase, series motor. Since it is unnecessary to supply the same amount of cooling air under all climatic conditions, arrangements have been made to connect two fan groups in parallel or series, so that two economical speeds may be obtained. During the winter the fan motors are connected in series, and consequently run at about half their normal speed, whilst in the summer they operate in parallel and the fans provide the maximum amount of cooling air.

The system of regeneration adopted was devised by the late Dr. Behn-Eschenburg, and is used on many single locomotives equipped with commutator motors. All the locomotive driver has to do to initiate regeneration is to move the master controller to the zero position, to turn the regeneration control handle from the motoring to the electric breaking position, and then to advance the master controller handle again to any desired operating position. A certain braking force corresponds to each braking step, regardless of the locomotive speed, and this braking force remains practically constant over the entire range in speed. To provide electric regeneration for the entire weight of the locomotive on the 1 in 37 gradient, additional apparatus in the form of four braking inductive coils, eight inductive commutating pole shunts, and eight ohmic commutating pole shunts is required, weighing in all 6 tons, or about 2·6 per cent. of the total locomotive weight.

To charge the 100-ampere-hour battery and to provide current for the control and lighting circuits, a hot cathode rectifier is installed in one section of the locomotive. There are two rectifier bulbs, one of which serves as a spare. Two double-stage, air-cooled, rotary compressors supply the air for the brakes and all pneumatically operated apparatus. When starting the compressor groups, the single-phase series commutator motors are connected directly to the 220-volt supply. In the event of no compressed air being available in the main reservoirs, a small compressor operated from the 36-volt storage battery is used for raising the pantograph current collectors. This auxiliary compressor is automatically started as soon as the pantograph control switch in the driver's cab is operated, and when the current collectors touch the overhead wire the main compressors are started. As soon as the main reservoir pressure reaches about 50 lb. per square inch pressure the auxiliary compressor shuts down. There is also a manually operated air pump by means of which the pantograph current collectors can be raised, if no current is available for operating the small auxiliary compressor.

A new system has been devised by the Oerlikon Company for testing the overhead line for voltage. In each driver's cab is a wireless tension indicating device, which gives an indication when the overhead line is alive. Before this apparatus was devised, an engine driver could only ascertain the condition of the line by raising one of the pantographs, involving the use of a certain amount of compressed air. If the operation was repeated a number of times, the use of the hand pump might be necessary, for if there was no current the main compressor could not operate. But the wireless indicator eliminates this disadvantage by indicating when the overhead line is energised.

All the Swiss Federal Railway locomotives are equipped with train heating apparatus, which can supply the heating line at 800 to 1000 volts. The new 12,000 H.P. engine is similarly equipped for an output of about 450 kVA, supplied by one of the main transformers. The main power and train heating circuits are protected by overload relays and upon their operation the main oil circuit breaker of the locomotive is tripped. There are eight instantaneous maximum current relays for the traction motor groups, two similar relays for the train heating circuits, two voltage relays for the automatic starting of the fan groups, two interlocking relays for the tap-changing drive mechanism, one instantaneous minimum tension relay with an auxiliary time relay, and a shunt relay, one minimum current time delay relay for the high-voltage circuit, and a blocking relay to prevent the tripping of the main oil circuit breaker in the case of heavy short circuits.

To reset the relays and to close the oil circuit breaker again in the event of one of these relays tripping, it is necessary for the locomotive driver to move the master controller to the zero position. This also initiates the "down" movement of the two tap changers to the zero position and only after the latter position has been reached is it possible to reclose the high-voltage oil circuit breaker and feed the traction motors and other circuits again. As the new locomotive is intended for one-man operation, it is fitted with the safety apparatus that has been standardised for all vehicles in the Swiss Federal Railways. It is also provided with the "Signum" automatic train control system, which is now being applied to all main line locomotives on these railways.

The cable system has been carefully carried out. All the cables are neatly tucked away in the lower part of the side walls, where they are readily accessible. Altogether about 10 miles of cable were used, with a total weight of about 3·5 tons.

School for Apprentices at Leyland

WE illustrate in the accompanying engraving the new day continuation school recently built at Leyland for the trade apprentices of Leyland Motors, Ltd. The work of equipping the building is now almost finished, and 350 boys are attending classes.

Built at a cost of £12,000, the new school includes two class rooms, a drawing-office, a laboratory for practical science, a handicraft room, a gymnasium measuring 70ft. by 40ft., changing and cloak rooms, a clothes drying room, a recreation room measuring 18ft. by 28ft., a staff room, and the headmaster's study. It is so laid out as to form a central quadrangle, which can be used for physical training instruction, and, in summer, for outdoor classes. The recreation room also serves as a club, for, even though the school may be closed, students are able to use the billiard table and table games, and take advantage of a library containing some 600 books.

Each apprentice attends the school during one full day per week. Mr. H. Darnell, B.Sc., the headmaster for the past nineteen years, and four assistants, all appointed by the county education authority, comprise the teaching staff, and look after about fifty students each day. Whilst at school each boy is paid at the recognised apprenticeship rate of his trade. During winter time he is expected to attend evening classes, either at the Leyland school or a local night school, up to three nights per week, and in summer to attend physical training classes, organised by the firm, for one night per week.

Run in conjunction with the Lancashire county education authority, the classes cover an extensive curriculum, for not only are the boys taught their trade, but they are given also a general education and a training in citizenship. For the first two years at the school the apprentice continues his ordinary general education, learning such subjects as mathematics and literature. In the third and last year, however, the training acquires an engineering bias, and, in fact, counts as the first year of the National Certificate course. The majority of the apprentices are eventually absorbed into the shops and offices of the company. Each year two apprentice scholarships are awarded, admitting the scholars to the firm's engineering premium apprentice scheme of training, a separate system designed to train boys for managerial positions.

At the factory a workshop training centre has recently been established for the boys. It contains various types of machines, including lathes, milling machines and grinding machines. Such parts as gauges for the tool-room and test pieces for the laboratory are made by the apprentices with this equipment, so that their efforts are directed towards useful production work. In all, there are no fewer than nineteen trades from which the apprentices may choose.

SCHOOL FOR APPRENTICES OF LEYLAND MOTORS, LTD.

DAIREN HARBOUR.—It is reported that Dairen harbour is to be doubled in size at an estimated cost of £5,000,000. The plan envisages the extension of the breakwater by 6560ft., the construction of new and extension of old piers, and the reclamation of 2600 acres of land.

NATIONAL FEDERATION OF IRON AND STEEL MERCHANTS.—The annual general meeting of the National Federation of Iron and Steel Merchants was held at Brettenham House, Lancaster Place, Strand, London, W.C.2, on Friday, July 7th. There was a good attendance of members. Mr. Ernest B. Hall, President of the Federation, took the chair. The business before the meeting was largely formal. Mr. Hall was re-elected President for the ensuing year, and Mr. V. G. McArthur, Chairman; Messrs. H. B. Darby, Arnold Carr, Noel Dore, Henry Kirk, G. A. Tawse, and J. H. Skelton, were re-elected members of the Management Committee. The meeting closed with a vote of thanks to the President.

WHITWORTH SOCIETY SUMMER MEETING.—The Whitworth Society held its Summer Meeting at Matlock and Derby on Tuesday and Wednesday, July 4th and 5th. A dinner took place at Smedley's Hydro on Tuesday evening, and on Wednesday the members left Matlock by motor coach, and inspected the Ladybower reservoir works of the Sheffield, Nottingham, Leicester, and Derby waterworks. On returning to Matlock for luncheon, the retiring President, Mr. W. Price Abell, installed the new President, Mr. E. Bruce Ball, who recalled that he was the fourth President of the Whitworth Society to be simultaneously holding office as the President of the Institution of Mechanical Engineers, his predecessors in this dual office being Dr. H. S. Hele-Shaw, the late Sir Henry Fowler, and Mr. Charles Day. After luncheon the members continued by motor coach to Derby for a visit to the Rolls Royce Company, where the organisation of production of aircraft engines in particular was seen. They were afterwards entertained to tea by Mrs. Lillingstone at Elvaston Castle.

GLASGOW TOWER OF EMPIRE.—The Empire Exhibition authorities at Glasgow announce that the Tower of Empire has been sold to George Cohen, Sons and Co., Ltd., and the Express Lift Company, Ltd., which has acquired the two high-speed lifts. The restaurant section at the base of the Tower has been dismantled, and the dismantling of the Tower itself will commence immediately. Its height is 300ft. and it contains 600 tons of steelwork. Within the last few weeks there have been a number of inquiries from local authorities and other interested parties, who have had under consideration the re-erecting of the Tower. As these inquiries have not reached finality, the Exhibition authorities accepted the offers made to them by the two companies, but entered into an arrangement whereby it would be possible to sell the Tower for erection elsewhere if the purchase were concluded during the next few weeks. George Cohen, Sons and Co., Ltd., have had considerable experience of dismantling lofty structures of this kind; two of their purchases were the Great Wheel at the Earls Court Exhibition, and the "Flip-Flap" at the White City.

Double-Ended Fettling Grinder

ILLUSTRATED in the accompanying engravings is a new high-speed grinding machine, termed by the makers, F. E. Rowland and Co., Ltd., of Climax Works, Reddish, the "Twin Drive" floor grinding machine. It has been designed for the rapid fettling of iron, steel, malleable, or non-ferrous castings, and also forgings and stampings. In order to make the machine as far as possible automatic in action and foolproof, several novel features are embodied which are claimed to eliminate waste of time in operation and maintenance.

We are informed that recently the use of high-speed grinding machines for removing surplus metal from castings and stampings has been considerably increased, for, by employing Bakelite-bonded grinding wheels, peripheral speeds up to 9500ft. per minute can be adopted, resulting in quicker production and less fatigue to the operator. Wheels of this type are used on the new machine. If the peripheral speed of the grinding wheel is allowed to drop below that for which the wheel was manufactured, particularly with synthetic resin-bonded wheels, extra wheel wear per unit of work done results, and there is a considerable loss in efficiency. It is therefore important that the peripheral speed should be maintained as nearly as possible the same as the recommended speed. Many double-ended grinding machines of the type under consideration are equipped with a three-speed drive to the wheel spindle, so that as the wheels wear the speed of the spindle can be increased, but for this arrangement to be fully effective the two wheels must wear at a uniform rate. In practice, it is found that the wheels do not always wear at the same rate, by reason of their unequal width, or of a difference in the strength and skill of the operators, or differences in the batches of components being ground. When the wheels differ in diameter it is impossible to run the smaller wheel at its correct speed without over-speeding the larger wheel and running the risk of the wheel bursting.

In order to overcome the difficulties discussed in the previous paragraph, the new machine has been designed with independent driving and control arrangements for each wheel, and is equipped with a speed-changing device which the operator must necessarily make use of when the wheel diameter decreases by wear by a predetermined amount. In this way unequal wheel wear can take place without loss of efficiency, and the time lost with single-spindle machines in changing speed and replacing the wheels is saved, since these operations affect only one operator at a time. In order further to reduce wasted time, a collet type of mounting is employed for the wheels instead of washer plates. Using this method, the time lost in wheel replacement is reduced, it is claimed, by 75 per cent.

In Fig. 1 is shown a view of a 24in. machine, and dust-collecting equipment. It is built in a range of three sizes for wheels, 30in. by 4in., 24in. by 3in., and 18in. by 2½in., each of which is provided with three independent changes of speed to each wheel, by the use of separate motor drives. This arrangement can be clearly seen in Figs. 2 and 3, where the cover at the rear of the machine has been removed. As mentioned above, the twin motor arrangement enables each wheel always to run at the most economical speed, and there is no waste of power when it is found necessary to run one wheel only.

Of rigid construction, the body casting has been designed to cover a large floor area, for the purpose of absorbing vibration, and to be of a convenient shape, so as to conform to the requirements of all usual operations. Each wheel is driven by its own spindle, composed of 40–45-ton tensile steel, ground all over. The driving motors are of standard type, and call for no mention beyond the fact that they are totally enclosed to protect them from abrasive and metal dust. The design of the spindle and wheel bearings, however, is of considerable interest. As is the practice in precision grinding machines, the spindle is arranged to transmit only driving torque, and is not subjected to journal loads, for the wheels are mounted on collets. These collets need not be disturbed for wheel replacement, for this operation can be carried out merely by the removal of an outer washer plate. Wear of the spindle end is thus avoided. Running on ball and roller bearings, the collets are mounted on a large diameter fixed sleeve, forming a dead spindle, and the journal load is therefore taken directly, without the need for the wheel to be overhung. The design permits large bearings to be used and this point, together with the absence of bending moments by reason of the bearing position, is claimed to result in smooth running and long life. The races are positively located, and no self-aligning bearings are used. Grease seals are provided to keep out dust and grit.

As shown in Figs. 2 and 3, the change-speed arrangements consist of independent sets of coned pulleys. The device used for changing speed is in two independent parts, one for each spindle, and is stated to be foolproof, as it is entirely controlled by the wheel diameter. The driving belts run in belt forks, which are connected by linkage and gearing to safety levers mounted in the wheel guards. The interlock thus provided is such that if the belts are on the high-speed pulleys a new wheel cannot be fitted. Furthermore, the speed cannot be increased from one step to the next unless the wheel has worn down to the corresponding diameter, so enabling the safety lever to move to the next position without coming into contact with the wheel. When the wheel wears to such an extent that an increase in speed is warranted, the wheel automatically stops and cannot be restarted until the necessary change has been made. In addition to maintaining an efficient peripheral velocity, this part of the automatic control ensures that there is no wide gap between the wheel and the work rest, a condition which is dangerous. The operation is through a limit switch, which is tripped when the work rest approaches each of three fixed positions. Connected in the starter circuit, this switch immediately cuts out the driving motor. By using a conveniently placed handle, the next higher speed can be engaged, and thereupon the limit switch moves clear, permitting the motor to be restarted.

Specially designed to comply with Home Office regulations, the wheel guards are substantially constructed in fabricated steel. They are arranged to be attached by bolts in tension tightened against extensions on the main machine body casting, so that none of the fastening bolts is in shear. An adjustment is provided so as to make them suitable for wheels worn down to any size, and they are equipped with hinged side doors to enable the wheel to be replaced easily. The work rests are iron castings, with the working surfaces chilled "dead hard," to resist wear and reduce friction. They are mounted on arms which can be readily adjusted for height.

In order to comply with the latest Factory Act regulations, efficient dust-collecting plant is necessary, particularly with high-speed machines. The type of apparatus supplied with this machine is illustrated in Fig. 1. It is a totally enclosed self-contained unit fitted with a motor-driven fan and a fabric filter, and provides a large volume of air for the purpose, namely, 800 cubic feet per minute.

The leading dimensions of the 24in. machine are given in the accompanying table:—

Grinding wheel.—Diameter	24in.
Face	3in.
Bore	8in.
Washer plate diameter	12in.
Spindle speeds, for wheel diameters of 24in., 20in. and 16in.	1512, 1814, 2268 r.p.m.
Wheel bearing diameter	3in.
Height from floor to wheel centre	2ft. 9in.
Number of driving motors	Two
Power of each motor	5 H.P.
Floor space necessary	5ft. 3in. by 4ft.
Weight	27 cwt.

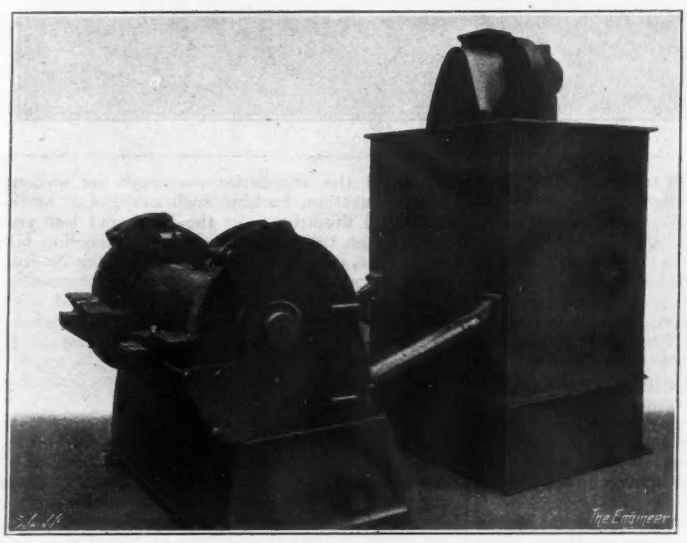


FIG. 1—FETTLING GRINDER AND DUST COLLECTOR

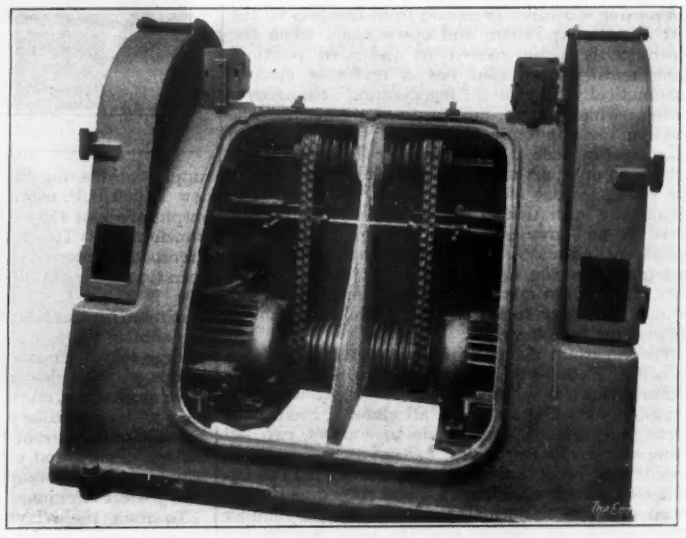


FIG. 2—GRINDER WITH REAR COVER REMOVED

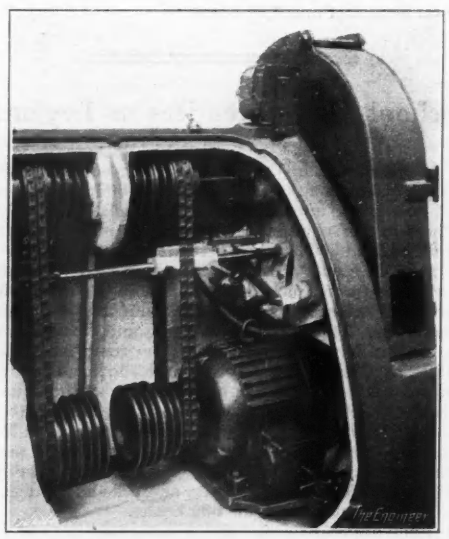


FIG. 3—CHANGE SPEED ARRANGEMENTS

PROFESSOR C. A. MIDDLETON-SMITH

WE learn with pleasure that at the thirty-second Congregation of the University of Hong Kong a few weeks ago, Professor C. A. Middleton-Smith, who recently retired from the position of Taikoo Professor of Engineering after nearly twenty-seven years' service, received the degree of LL.D. (*honoris causa*). When inviting the Chancellor to confer the degree, Professor F. A. Redmond, Dean of the Faculty, spoke at some length on the engineering value of Dr. Middleton-Smith's work to the University, and stressed particularly the fact that he was always "the student's friend." We may add that we are particularly gratified by this honour, because for several years Dr. Middleton-Smith was our permanent correspondent in China, and the author of many delightful letters which have appeared in our columns.

AMERICAN STEEL INDUSTRY LOSSES.—Information received by the American Iron and Steel Institute from nearly a hundred companies, representing over 90 per cent. of the total output of United States steel industry, showed that a net loss of nearly 15 million dollars was incurred during 1938. This is the fifth year since 1930 in which the industry showed a net deficit.

Rail and Road

FINNIESTON BRIDGE.—The Glasgow Corporation has approved a modified scheme for a bridge across the Clyde at Finnieston. The design is of a "tied arch" type instead of the cantilever scheme previously proposed.

MEXICAN RAILWAY EXTENSIONS.—It is reported that good progress is being made on the 478 miles of new line linking Puerto, Mexico, with the Yucatan system in Campeche. It is hoped that the line, which will cost about 105 million dollars, will be completed in 1940.

BEKONSCOT MODEL RAILWAY.—The Bekonscot model railway, village, and garden, at Beaconsfield, was open to the public on July 9th, in aid of various charities. During the year ended June 30th last, £1249 was collected for charity, and the number of visitors totalled 28,871.

UNREMUNERATIVE BRANCH LINES IN INDIA.—An investigation into the earnings of all the branch lines by the Indian Railway Board has revealed that seven lines worked by the South Indian Railways and three by the North-Western administration are working at a loss.

BOSPORUS TRAIN FERRY.—A credit of 4½ million Turkish pounds—about £750,000—has been voted by the Kamutay to create a train-ferry service across the Bosporus between Birkedji and Haidar Pasha. When completed the ferry service will enable rail communication to be made between Europe and Asia at Istanbul.

RAILS FOR SOUTH AFRICA.—The South African Railways and Harbours Administration has recently placed orders aggregating 66,000 tons of steel rails among nine firms in this country, supplying 37,000 tons at a cost of £318,250, and two Canadian firms, supplying 29,000 tons at a cost of £282,750. The rails will be carried in British bottoms, and with the cost of freight added will cost nearly £700,000 in all.

NEW GERMAN ELECTRIC LOCOMOTIVE.—A new electric locomotive capable of an average speed of 112 miles an hour has been taken over by the Reichsbahn for service on the recently electrified line between Nuremberg and Saalfeld. It is stated that for special purposes the locomotive can reach a speed of 140 miles an hour, and when the line from Berlin to Munich is fully electrified the travelling time will be reduced from 8 to 5½ hours.

WIDENING HOUNSLOW RAILWAY BRIDGE.—A scheme for the widening of the bridge carrying Sutton Lane, a county road in Hounslow, over the District Railway, at an estimated cost of £17,060, has been approved by the Middlesex County Council. It is proposed to widen the bridge from approximately 35ft. to 64ft. to provide for the construction of twin carriageways, each 20ft. in width, a central reserve of 4ft., and two footpaths, each 10ft. wide.

SHOCK-ABSORBING WAGONS.—Following the success of the special shock-absorbing freight wagons first introduced by the London Midland and Scottish Railway Company as an experiment in 1938, the company has decided to construct a further 300 of these special vehicles, bringing the total stock up to 506. Of the new vehicles, all of which will be constructed in L.M.S. workshops and delivery of which will begin in September, 250 will be of the hand-braked type and 50 of the vacuum-braked type, the latter being suitable for running on the fastest freight trains. They will all be of 12 tons capacity.

CARNFORTH STATION IMPROVEMENTS.—An important stage of the station modernisation scheme which the London Midland and Scottish Railway Company is carrying out at Carnforth was reached on Sunday, July 2nd, when the new "down" platform for trains to the Barrow-in-Furness direction was brought into use, together with the appropriate signalling equipment. This new platform is 890ft. long, and its introduction will greatly ease the working of summer holiday traffic through Carnforth, as hitherto trains both to and from the Furness line have had to be accommodated at one platform.

ROAD-RAIL CO-ORDINATION.—The Road and Rail Central Conference, established as the result of the agreement between the two systems of transport, is making rapid progress in the organisation of machinery throughout the country to co-ordinate charges for goods traffic in anticipation of the Bill which the Minister of Transport has promised to introduce in Parliament during the next session. In order that prompt progress may be possible as soon as the Bill becomes an Act, committees have been established in every traffic area of the country. The first meeting of the Regional Committee for the Metropolitan Area is to be held at the Great Northern Hotel, King's Cross, on July 18th.

CONCRETE ANCHORS FOR BRIDGE CAISSONS.—In order to overcome the difficulties, caused by deep water and swift currents, in the placing of caissons for the construction of the piers for a new 2600ft. suspension bridge across the Tacoma Narrows, in the United States, a series of concrete anchor blocks, weighing 600 tons each, is being placed around the sites of the piers. Each caisson will be surrounded by at least twenty-four of these anchors, placed on the bottom on the circumference of a circle 924ft. in diameter in groups of two or four alternately. Each anchor is 12ft. by 12ft. and 51½ft. long, with seven transverse ridges on each side to increase resistance to sliding along the bottom. Two 3in. U bolts in each anchor will be attached to the caisson by anchor cables.

NEW APPOINTMENTS ON THE G.W.R.—The Great Western Railway Company announces the following appointments to take effect from July 24th:—Mr. W. N. Pellow, divisional locomotive superintendent, Bristol, to be divisional locomotive superintendent, Old Oak Common; Mr. C. L. Simpson, assistant to locomotive running superintendent and outdoor assistant to chief mechanical engineer, Swindon, to be divisional locomotive superintendent, Bristol; Mr. H. G. Kerry, assistant divisional locomotive superintendent, Old Oak Common, to be assistant to locomotive running superintendent and outdoor assistant to chief mechanical engineer, Swindon; Mr. L. G. Morris, assistant to divisional locomotive superintendent, Newton Abbot, to be assistant divisional locomotive superintendent, Old Oak Common, London.

Miscellanea

SCIENCE RESEARCH SCHOLARSHIP.—The Royal Commissioners for the Exhibition of 1851, London, have awarded the Science Research Scholarship for 1939 to Dr. Prem Bihari Mathur, D.Sc., of the Institute of Agricultural Research, Benares Hindu University.

EARLS COURT, LTD.—It is announced that the board of Earls Court, Ltd., has received notice that the trustees of the First Mortgage Debenture stockholders propose to apply to the Court for the appointment of a receiver and manager. The company was formed in 1935 and has paid no dividend since on its share capital.

WINDMILLS AND WATERMILLS.—An exhibition is being held at Antwerp illustrating windmills and watermills, their history and technique. In 1847 Belgium had 2739 windmills and 2634 watermills, but most of them have now been demolished. The exhibition is being held with the object of drawing public attention to the fate of the mills of Belgium and preventing their total disappearance.

THE INSTITUTION OF MINING ENGINEERS.—At a meeting of the Council of the Institution of Mining Engineers held at Sheffield in connection with the Summer Meeting, Mr. E. O. Forster Brown was unanimously elected to succeed Colonel Sir Frank R. Simpson as President in January, 1940. Mr. Forster Brown has been a co-opted Member of Council of the Institution for a number of years, and he was a member of the Royal Commission on Safety in Coal Mines, of which Lord Rockley was Chairman.

A PLASTICS ADVISER FOR THE WAR OFFICE.—It is announced that the Directorate of Scientific Research for the War Office (and later for the Ministry of Supply when formed) is seeking an adviser on plastics (plain and reinforced). His duties will include advice on the actual and potential uses of plastics as materials of construction for Service purposes; correlation of current research and development in this field; and the maintenance of close contact with industry and with the departmental design and production branches.

AMERICAN MACHINE TOOL SHOW.—The 1939 Machine Tool Show will be held in Cleveland, October 4th to 13th. Both in number and range of exhibits and in improvements in performance and design of machine tools, this year's Show is expected to surpass the last Show, which was held in Cleveland in 1935. The Show will be housed in Cleveland's 15,000,000-dollar Public Auditorium, which contains over 6 acres of exhibition floors. Of this space, 150,000 square feet will be taken up by the actual booths of exhibitors, ranging in size from 200 to 4000 square feet. All of the available exhibit space has for some weeks been oversubscribed, and original requests for exhibit space have had to be cut in order to hold the total booth space within available limits.

PROGRESS IN THE SPECIAL AREAS.—According to a progress report of the Commissioner for the Special Areas in England and Wales, there were 106 completed factories on the Team Valley Trading Estate at the end of May last. Of these, 99 were occupied and 98 were in production, employing 2525 people. Nine further factories were under construction for prospective tenants. On the detached sites at Pallion, St. Helen, Auckland, and Tynemouth there were eight factories completed and occupied, two under construction and 589 persons were employed in the factories, whilst 672 were engaged in construction work on the estates. On the Treforest Estate forty-six out of the fifty-five completed factories were occupied, giving employment to 1868 people.

MONEL METAL.—An interesting brochure recently issued by Henry Wiggin and Co., Ltd., gives an account of the properties, principal uses, fabrication, and available forms of monel metal. It is pointed out that the alloy takes its name from that of Mr. Ambrose Monell, who was president of the International Nickel Company at the time when the alloy was first produced in 1905. This company had for many years been engaged in mining and smelting the nickel ores from the Sudbury district of Ontario, Canada. One large belt of ore was found to contain, in addition to the nickel, a relatively high percentage of copper. As separation of the two metals under these conditions was both difficult and expensive, it was decided to smelt out the two metals simultaneously and to examine the commercial merits of the resulting alloy.

GENERATION OF ELECTRICITY.—The Official Returns rendered to the Electricity Commissioners show that 1912 million units of electricity were generated by authorised undertakers in Great Britain during the month of June, as compared with the revised figure of 1612 million units in the corresponding month of 1938, representing an increase of 300 million units, or 18·6 per cent. The number of working days in the month, excluding Sundays, was twenty-six as against twenty-five last year. During the six months of 1939 up to the end of June, the total amount of electricity generated by authorised undertakers was 13,571 million units, as compared with the revised figure of 11,954 million units for the corresponding period of 1938, representing an increase of 1617 million units, or 13·5 per cent.

NICKEL PLATING.—A report presented at a meeting of the American Electrochemical Society by Messrs. W. A. Wesley and J. W. Carey states that nickel deposited from a nickel-chloride-boric acid solution is finer-grained, smoother, harder, stronger, and less ductile than soft deposits from the ordinary sulphate electrolyte. Tests showed that the coatings from the two types of baths are of about equal protective value when of equal thickness. Laboratory tests indicated that advantages which can be obtained from electro-plating from the chloride solution instead of the sulphate bath include the following:—A 50 per cent. reduction in tank voltage and power consumption, ease of control, wide plating range, high cathode and anode efficiencies, lower susceptibility to pitting, smoother and tougher deposits, and the production of coatings which are easier to buff. The principal disadvantage of the chloride bath is the greater corrosiveness of the solution, but it is pointed out that use of improved modern materials overcomes this objection.

Air and Water

GIFT FOR SPORT IN THE R.A.F.—Lord Rothermere, who was Secretary of State for Air when the Air Ministry was created in 1918, has made a gift, the Air Ministry states, of £10,000 for the general benefit of R.A.F. sports, with particular reference to inter-unit competitions.

SECRETARY OF UNITED STATES NAVY.—We regret to record the death of Mr. C. A. Swanson, Secretary of the Navy in the United States Government, who died at the age of seventy-seven on July 7th. Mr. Swanson had always taken a deep interest in the United States Navy, although he had spent forty years of his life in politics.

ANTARCTIC AIR BASES.—The United States Government has commissioned Admiral Byrd to leave for the Antarctic in October with about seventy men to claim for the United States an unspecified land lying within the Western Hemisphere and regarded as having potential value as a site for air bases. Three ships will be taken and it is hoped that three bases will be established.

INTERNATIONAL AIR CONGRESS.—An International Air Congress will be held at Stratford-on-Avon from July 8th to 13th, 1940, organised by the Royal Aeronautical Society, at which there will be papers and discussions on the technical aspects of aviation. A detailed programme will shortly be available for distribution, and any further information which may be required will be supplied by the organising secretary, International Air Congress, 1940, 4, Hamilton Place, London, W.1.

LONDON'S SHIPPING.—During the week ended June 30th, 884 vessels, representing 1,053,864 net register tons, used the Port of London. Of this total, 498 vessels (876,692 net register tons) were to and from Empire and foreign ports and 386 vessels (177,172 net register tons) were engaged in coastwise traffic. During the week ended July 7th, 985 vessels, representing 1,087,161 net register tons, used the Port of London. Of these, 510 vessels (901,208 net register tons) were to and from Empire and foreign ports, and 475 vessels (185,953 net register tons) were engaged in coastwise traffic.

"MAURETANIA'S" MAIDEN VOYAGE.—The new Cunard White Star liner "Mauretania" completed her maiden round voyage across the Atlantic at Southampton on Friday, July 7th. She took 5 days 22 h. 22 min. for the homeward voyage from Ambrose Channel Lightship to Cherbourg breakwater, an average of 22 knots. Sir Percy Bates, chairman of the company, was unable to say whether a sister ship would be built, but added that the "Mauretania" would be called on at times for the express North Atlantic service from Southampton when the liners "Queen Mary" and "Queen Elizabeth" were being overhauled.

AIR MINISTRY DIRECTOR OF WORKS.—It is announced that Mr. E. Holloway is to be Director of Works, Air Ministry, in succession to Colonel J. F. Turner. Mr. Holloway was appointed as a civil engineer in the Directorate of Works of the Air Ministry in 1920, and after serving in various posts at home and abroad, was appointed Assistant Director of Works in 1934, and Deputy Director of Works in 1937. Colonel Turner held the appointment of Chief Engineer, Royal Air Force, India, from 1928 to 1931, when, on retirement from the Royal Engineers, he was appointed Director of Works under the Air Ministry.

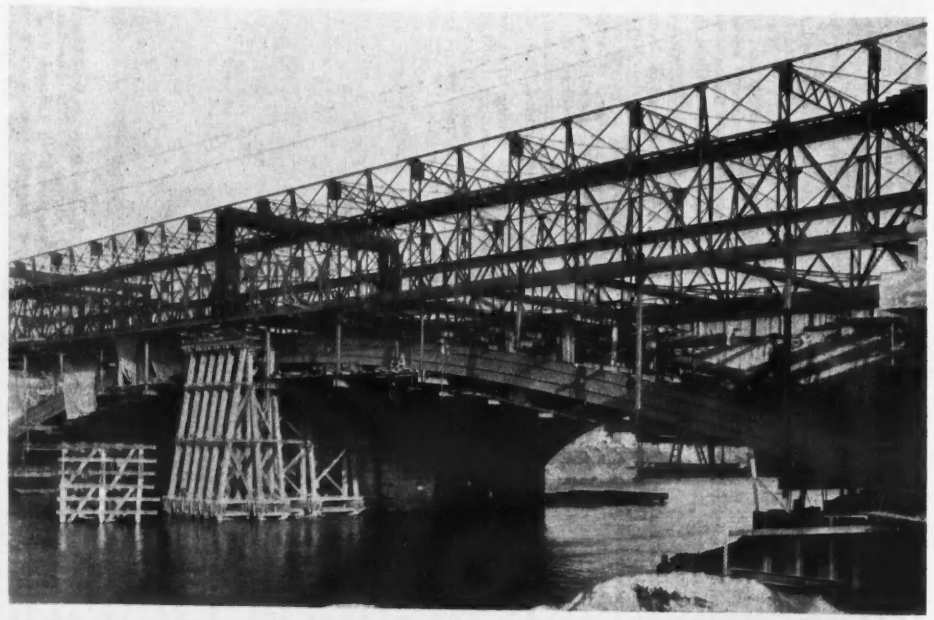
NORWEGIAN SHIPPING.—A review of Norwegian shipping during 1938 by the Norwegian Shipping Bureau shows that during the year the merchant tonnage increased by 213,000 gross tons to an aggregate of 4,756,000 gross tons. The gross increase of tonnage last year amounted to 384,000 gross tons and 245 ships, of which 202 ships aggregating nearly 305,000 gross tons were motorships. Of the new motorships, 40, aggregating 244,667 gross tons, were built abroad, and 38,800 gross tons of second-hand motor tonnage was purchased abroad. Steam tonnage increased by approximately 79,000 gross tons, of which 24,400 tons were new ships built in Norway, and over 54,000 tons were foreign, second-hand tonnage.

R.A.F. VOLUNTEER RESERVE.—The Air Ministry announces that arrangements have been made in consultation with the Ministry of Labour and the Commissioners of the Civil Air Guard whereby persons of sufficient flying experience will no longer be excluded by the Schedule of Reserved Occupations from joining the Auxiliary Air Force or the Royal Air Force Volunteer Reserve as pilots, or from becoming members of the Civil Air Guard. Persons with such experience who volunteer to join one of these services should state that they have had previous flying experience on the form E.D. 60 when submitting it to the Ministry of Labour. They should also state whether they hold an Air Ministry "A" licence, and, if so, the number of hours solo flying experience they have had, and whether they also hold a "B" licence, and whether they have at any time served as pilots with the Royal Air Force, its Reserves, or Auxiliaries.

NEW FLYING-BOATS FOR THE EMPIRE ROUTES.—Three big new flying-boats are now taking their place on the India section of the Imperial Airways Empire routes. They replace the land-plane air liners operating supplementary services between Alexandria and Karachi, releasing the crews of the land-planes for training on the new "Ensign" aircraft at Croydon. The three new flying-boats, "Clyde," "Awarua," and "Australia" will be replaced eventually by the "Ensigns," which are to operate a permanent land-plane service between London and Calcutta, duplicating the present flying-boat service on this route. The first of the new flying-boats, "Clyde," left for Karachi on July 3rd. "Australia" was scheduled to go into service on the same route on July 6th, and "Awarua" on July 12th. Ultimately "Clyde" is expected to operate on the New York and Bermuda service, while "Awarua" and "Australia," together with their sister ship "Aotearoa," will fly on the Tasman Sea route between Australia and New Zealand. Fourteen "Ensigns" in all will enter service this year. The first of the six scheduled for European routes is now operating, together with "Frobisher" class air liners, on the daily services between London and Paris.

RECONSTRUCTION OF THE PARIS-NEUILLY ROAD BRIDGE

(*For description see page 30*)



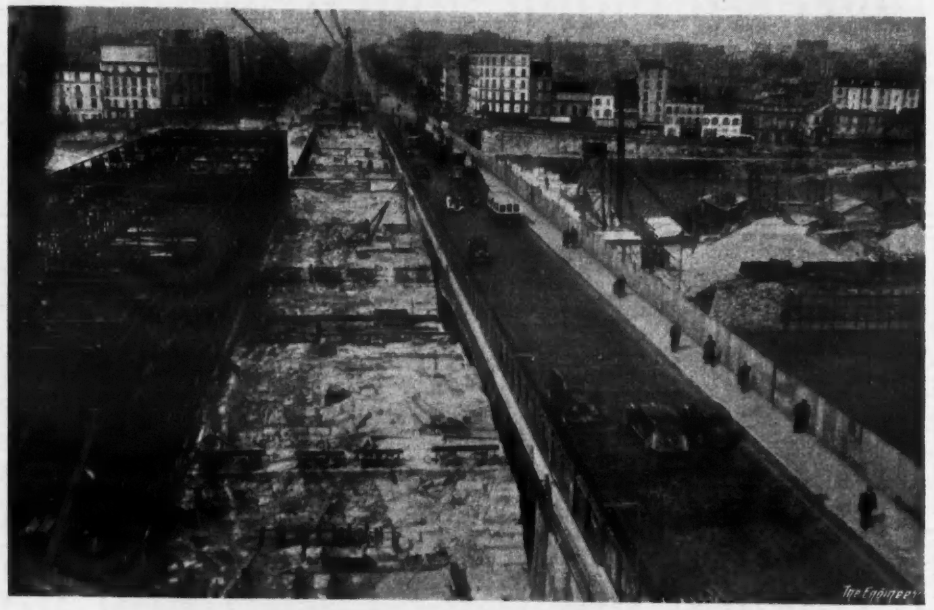


FIG. 11—CONSTRUCTION BRIDGE ON TEMPORARY TIMBER PIER

FIG. 12—CONSTRUCTION BRIDGE WITH STAGING FOR ERECTION

FIG. 13—BRIDGE IN EARLY STAGE OF RECONSTRUCTION

FIG. 14—DISMANTLING OLD BRIDGE

The Engineer

JULY 14, 1939

VOL. CLXVIII No. 4357

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ONE-PAGE SUPPLEMENT—PENCIL PORTRAIT NO. XX: SIR FRANK E. SMITH, G.B.E., F.R.S.

NOTICES TO READERS

**** If any Subscriber abroad should receive* THE ENGINEER *in an imperfect or mutilated condition, he will oblige by giving prompt information of the fact to the Publisher, with the name of the Agent through whom the paper is obtained. Such inconvenience, if suffered, can be remedied by obtaining the paper direct from this office.*

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**** All letters intended for insertion in* THE ENGINEER *or containing questions should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

**** No undertaking can be given to return drawings or manuscripts; correspondents are therefore requested to keep copies.*

CHANGES OF ADDRESS

**** Will Subscribers please note that in all advices regarding changes of address it is necessary to have* **both the old and new addresses,** *as our lists are kept alphabetically by towns. Advices of this nature should reach us by the first post Wednesday morning prior to the alteration.*

Postal Address: "The Engineer," 28, Essex Street, Strand, London, W.C.2.

Telegraphic Address: "Engineer Newspaper, Estrand, London."

Telephone: CENtral 6565 (10 lines).

Pencil Portrait No. 20

With to-day's issue we present a Pencil Portrait of Sir Frank E. Smith, G.B.E., F.R.S. Early this year Sir Frank relinquished his position as Secretary to the Department of Scientific and Industrial Research to take up an appointment as Adviser on Research and Development to the Anglo-Iranian Oil Company. From 1922 to 1929 he was Director of Scientific Research at the Admiralty, and has served as Secretary to the Royal Society, and as Honorary Secretary to the British Association for the Advancement of Science.

STANDARD LOCOMOTIVES ON STANDARD PERMANENT WAY

IN our last issue we presented the conclusions arrived at by a Committee appointed to inquire into the behaviour of "Pacific" locomotives on Indian railways, and outlined, in a leading article, the general nature of the report presented recently to the Government of India by the Committee. Whilst the Committee sprang from the Bihta derailment, and the stability of the Indian "Pacifics" received particular attention, many other questions were discussed. The original cause of the adoption of the 4–6–2 type wheel arrangement for the heaviest class of Indian express locomotives lay in the desire to burn a cheaper class of coal and produce economies thereby. The employment of such lower grade coal led of necessity to the use of a wide fire-box, and this, in turn, practically necessitated the adoption of the "Pacific" type wheel arrangement, at that date new to Indian railways. The use of the "Pacific" type has in practice under Indian conditions caused material increase in permanent way costs, and one question that springs to the mind—not only in connection with railways in India, but throughout the world—is whether the employment of ever lower grades of coal can be economically justified. Admittedly, it is an attractive proposition for those concentrating on saving to suggest the purchase of poorer quality fuel, but, if such a policy leads to the adoption of locomotives, heavy as regards their own maintenance and heavy on the road, such a penny-wise policy may prove pound-foolish. Furthermore, in some countries, not excluding Great Britain, the smoke nuisance may lead, as it has done in the United States, to heavy expenditure on air conditioning—though the urge to this often comes from climatic conditions. There are many who hold the view that British express train operation is not as good in this respect as it used to be, at least on certain of the lines. The Great Western locomotive policy has been built up on the use of excellent South Wales coal, and the smoke nuisance is usually remarkable for its absence on that line and certain other sections of the British railways. Thus one point emerging from this report is that the search for economies in fuel consumption has led to increases in costs in other directions, which must be set against the reduction in the coal bill.

Another instructive point is the wide variation in the degree of satisfactory running achieved by the different classes of "Pacifics" under review on the Indian railways. One gathers from the report that certain systems experienced little difficulty with them; on others these locomotives developed unsteady running soon after being placed in service. To some extent this can be ascribed to the different types of sub-formation and their geographical location, but whilst the wide variation in running cannot be ascribed wholly or only to track foundation, the report makes it clear that even on the individual systems important differences exist, and the position seems to be accentuated by the extraordinary variety of types of sleepers, fastenings, and weights of rails in use. Admittedly, India is a huge area, and the problems of standardisation are in consequence difficult. But Europe also covers an enormous area, and the United States and Canada contain over a quarter of the world's railway mileage; nevertheless, there would appear to be greater variations in India with regard to permanent way design than in the whole of Europe, or even in North America, as measured between Churchill and New Orleans or Halifax and Los Angeles. Hence the thought arises that it might have been wiser to concentrate on standardising the permanent way as a means of strengthening it before attempting to standardise heavier and faster locomotives intended to run on it. If it was out of the question to reduce the widely varying existing types of track to a single standard suitable for such standard engines, it seems that a higher degree in the standard of maintenance was called for and that does not everywhere appear to have been attained. On this point it is worth quoting from the conclusions to the report, as given in our last issue: "With regard to the suitability of the track for these engines, there is little doubt that when they were introduced they immediately reacted to weak spots; but we are satisfied that, generally, suitable action by speed restrictions and strengthening was taken to meet the situation which arose from introducing machines, the capacity of which may be said to have been materially ahead of the characteristics of the track." Turning to the engines themselves, it appears that, however gently the report makes the point, there does appear to have been a lack of co-operation between the responsible authorities in India and the consulting engineers and locomotive builders in this country at the time the locomotives under review were designed and constructed. It must, however, be admitted that the degree of co-operation to be desired was no easy matter to achieve in practice, more particularly in days when mails took much longer than they do to-day, and it is worth noting that the later and possibly parallel case of South Africa has revealed no similar problem of equal magnitude. It seems clear that inadequate maintenance played an important part in the troubles experienced with these "Pacific" classes, and in various sections of the report reference is made to difficulties arising with frames, bogie control, coupling-rods, and hot boxes. Few new locomotive types are free from teething troubles, but these specific classes of "Pacifics" appear to have developed troubles tending to increase as the years passed, an unusual and disturbing feature, and one by no means solved at the time the Committee was conducting its inquiry. The lack of spare parts is an unexpected feature arising from the report, because the essence of standardisation rests on the greater availability of spares, and, indeed, one of the fundamental questions which will demand close attention when the report comes to be studied by the responsible authorities is the whole conception of the term "standardisation" and the economies to be derived therefrom.

Thus, even if the various Indian railways were ripe for the reception of a large class of standard express locomotives, the value of such a policy seems to have been materially reduced by the widespread allocation of the locomotives on their arrival. For standardisation to be effective, the repairs to any one class should be concentrated on one repair shop; such a policy has been the secret of the economies obtained at Crewe, Derby, Swindon, Doncaster, Stratford, &c. With the wide areas applicable in India, if a standard class is to be set to work throughout the whole country on, say, eight large systems, the whole theory of standardised repairs would seem to negative itself, at any rate partially. This is a matter which will also merit close attention or even complete review, and perhaps Canadian practice with similar huge distances may prove useful in providing guidance. We may add that whatever the outcome of the present report may be, improvement of the existing system must inevitably be costly and the financial position will therefore call for the closest attention and examination.

A New Conception of Business

THE equitable distribution of the profits of industry between the three parties essential to every industrial undertaking—the worker, the capitalist, and the consumer—is a problem that has puzzled many honest brains, and is one that has led to the evolution of a number of schemes for profit sharing, distribution of bonuses, and many other proposals, all of which can at best be regarded as palliatives. We have now before us a new conception of business, and it comes from a man who has become increasingly dissatisfied with business as it is known to-day, in that its ideal is to make money rather than to serve society. Mr. Frank Murphy is of the opinion that most people are not truly happy in their life to-day, in that there is not that freedom which is essential to happiness. Everyone in industry, he holds, should have the right to liberty of conscience, access to knowledge, and freedom of speech. But with these rights must go hand in hand three distinct obligations—the acceptance of individual responsibility, the willingness to impart knowledge, and the readiness unreservedly to discuss problems. Unless the rights are conceded the obligations will not be accepted, and accordingly at the present day there is not the freedom which all crave. Mr. Murphy contends that most of us are now trying to live in two different worlds—a democratic one in politics, but a dictatorial one in business—and as he thinks the two cannot indefinitely exist side by side, and he favours a democratic outlook, he sets about demonstrating that business can be run as a democracy. That he has the courage of his convictions is shown by the fact that after starting in business as a radio manufacturer, and being dissatisfied with business as ordinarily practised, he disposed of all his shares and used the proceeds for developing his new conception of business and interesting others in his proposals.

It is an easy matter to enunciate principles,

and to evolve schemes for the betterment of humanity, to teach and to preach in the hopes that others will do the experimental work; but Mr. Murphy has at least acted himself, putting his ideas to the test in the business of Frank Murphy, Ltd., manufacturers of furniture and furnishings. Instead of trying to sell his goods in the usual way, that is by attempting to convince a purchaser that he really wants what is offered, Mr. Murphy rather ascertains the needs of the community, makes articles calculated to satisfy those needs, and then does not seek to influence the potential customer. Applying his principles as to rights and obligations, not only must the manufacturer, but also the customer, be intelligently satisfied. Everything must be done by consent. Although the governing director has vested in him supreme executive authority, his appointment is in the hands of an honorary board of trustees who have no financial interest in the concern, and who can dismiss him provided that they are unanimous that he has committed an act detrimental to the ideals of the company. Shareholders are entitled to a cumulative dividend at the rate of 6 per cent. per annum, but if undue profits are made these will eventually be returned to the customer. The worker under this system, while enjoying his rights and recognising his obligations, is given conditions of work which should satisfy the most fastidious. Although initially appointed for a temporary period, when this has passed to his own satisfaction and that of a staff committee, the employee's appointment is made permanent, and thenceforth he can only be dismissed for lack of integrity. The bogey of unemployment is banished. After ten years of service he will be entitled to a pension, on a non-contributory basis, if incapacitated by age or infirmity. The dread of old age recedes. When sickness overtakes him the company will pay full wages, less any benefit received from National Health Insurance. The fear of illness and its effect on the family budget no longer haunts him. He will be entitled to not less than a fortnight's holiday each year, in addition to all statutory holidays, with pay. Should the employee be a woman, she may receive an *ex gratia* payment on marriage, and she alone will make the decision as to whether she stays with or leaves the company. There are none of the usual incentives to output, such as piecework, premium, and the like, for they are unnecessary. All are working intelligently and happily. No additional payments are made for overtime, which is worked voluntarily when necessary, for compulsion is unknown, being alien to that spirit of liberty which is the mainspring of the organisation.

We cannot find fault with the ideals of this new conception of business, for we should welcome the best conditions for all engaged in industry; but what we are concerned with is the practicability of the scheme in a world where manufacturers generally are not actuated by the same lofty principles. To ensure the happy and permanent state of affairs envisaged, it is essential that a continual and steady flow of orders be forthcoming. But can this be ensured? In the extreme case of the whole community refusing to buy furniture, even at the cheapest rate, where would the funds be raised, not only to pay pensioners, but also the idle, but permanent, employees; for clearly manufacture for stock could not be continued indefinitely? To build up a reserve fund to meet all contingencies would throw a heavy burden on manufacturing costs, tending to curtail the selling value of the product. Could the monopoly of furniture making or of any other commodity be secured, the success of the scheme might be anticipated, but the acid test is a time of adversity, and frankly we are sceptical as to the manner in which this test would be met. Profit-sharing schemes have been launched, acclaimed, and put into operation in a period of prosperity, only to find that when lean days arrive those who were prepared to share the profits are not prepared to—indeed, in many cases, cannot—share the losses. Accordingly, before we are prepared to accept the practicability of this new conception of business, we shall want to watch it in operation, not for one or even two or three years, but over an extended period.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

"PACIFIC" LOCOMOTIVE ON INDIAN RAILWAYS

SIR,—Your Leading Article and the concluding remarks of the Committee sent out by the Government of India to report upon the above type of locomotive interested me very much because I had to test and report on this type of locomotive so far back as 1921, while technical officer on the Bengal-Nagpur Railway. It was decided that this type of locomotive be used to work the special trains for H.R.H. the Duke of Connaught and Strathearn. A careful test was ordered and carried out by me. On referring to some notes made then for compiling the report of the running test for consideration of the chief mechanical engineer, the following appeared:—

(1) When brakes were applied, deflection of springs more than usual. Cause, weak springs or position of brake blocks being below horizontal centre line of wheels.

(2) Bogie wheel springs not strong enough at certain sections of line, excessive oscillation. Track reported O.K.

(3) Speed, maximum test 62 m.p.h. (thought engine would leave track at one section) after passing (B.S.P.).

(4) Recommend that maximum speed while drawing special train be no more than 45 m.p.h.

(5) Introduce correct spring adjustment for brake blocks.

I have not seen the report published by the Committee, but believe it would be very interesting to read.

G. JORDAN.

Rugby, July 8th.

Literature

SHORT NOTICES

Power Factor Economics. By Price L. Rogers. London: Chapman and Hall, Ltd. 1939. Price 12s. 6d.—The author of this book deals with power factor from the point of view of private plant owners and those associated with the distribution side of public electricity supply undertakings. The meaning of power factor and the reasons for it being less than unity are explained. Methods of making power factor tests are also considered. Corrective methods, including the use of condensers, synchronous and other motors, are dealt with at considerable length, but no mention appears to be made of phase advancers. Many tables included in the book are designed to help engineers to solve power factor problems, such as that of finding the capacity of a condenser necessary to raise the power factor from one value to another. A chapter of special interest to power users is that which deals with industrial power factor studies in which the savings likely to arise as the result of power factor improvement are calculated for specific cases. Power loss and conductor drop are discussed in a subsequent chapter. The second part of the book, devoted to power factor problems on distribution systems, is less lengthy than part one, but is, nevertheless, quite useful, particularly to engineers interested in the application of condensers to overhead distribution lines. Although it cannot be said that there is a dearth of literature on power factor and its correction in this country, the present volume deals with it in considerable detail and throws light on American practice.

Electrolytic Condensers. By Philip R. Coursey. London: Chapman and Hall. 1939. Price 10s.—In preparing the second edition of this book the author has taken the opportunity to remove a few errors that crept into the original text and to give attention to various suggestions made by readers. A more logical treatment has been adopted in the opening of the book to emphasise the distinctions between electrolytic and other forms of condensers, while new matter has been added dealing with the equivalent circuit of electrolytic condensers. In order to give data concerning the latest developments and constructions of these condensers, a considerable number of additions have been made throughout the remainder of the book. Special attention has been paid to the "etched" forms of dry condensers and to "surgeproof" dry condensers. The latest forms of wet condensers are described. Additional data on the electrical characteristics of the condensers are given, including information on the expectation of life of the various forms. Consideration of the applications of the newer types of condensers and the manner in which they compare with and fit in with the older types has been elaborated. The final chapter on the applications of electrolytic condensers has been rearranged and enlarged so as to divide the uses into two groups, depending upon the class of condenser employed therein.

An Introduction to Electrical Engineering. By E. W. Marchant. London: Methuen and Co. 1939. Price 12s. 6d.—Based on lectures to university students in civil, mechanical, and electrical engineering during the last twenty-five years, this volume is intended as a textbook for students taking a first and second-year course in electrical engineering at a university or technical college. Readers are assumed to have a knowledge of physics up to the standard of matriculation. The Giorgi system of units is adopted throughout the book, but the relation between them and the C.G.S. units is explained so that students who have been taught physics on the C.G.S. system can understand the necessary changes in the values of absolute permeability and permittivity which are required in the system adopted. Only those parts of the subject which are regarded as essential for a proper understanding of the apparatus and machines described have been included. At the end of each chapter problems are set for the student to solve.

The Performance and Design of Direct-current Machines. By Albert E. Clayton. London: Sir Isaac Pitman and Sons, Ltd. 1938. Price 16s.—As little has been added since the first edition of this book was published to engineers' knowledge of the theory and performance of D.C. machines, the author has not found it necessary to make any radical alterations to the text of this second edition of the book. Developments have, however, taken place in the construction of D.C. machines, particularly in the construction of frames, which are now generally fabricated. The author has therefore deemed it advisable to replace most of the drawings and other illustrations of the construction machines by those representing modern practice. As, moreover, the use of ventilating fans has been extended and loading constants have increased somewhat, the data given for these constants have been revised.

Sixty Years Ago

EARLY GAS ENGINES

IN our issue of July 11th, 1879, we published an article describing the gas engines exhibited at the Royal Agricultural Society's Show at Kilburn. We believed, we said, that our article mentioned all the engines at the Show, but it was possible that some others had been buried in the mud of the show yard or were otherwise inaccessible to the visitor. The largest exhibitors of gas engines were Crossley Brothers, of Manchester, who showed six Otto silent engines, ranging from ½ to 16 H.P., the last named being the largest gas engine ever made. We found no novelties of construction in any of the Crossley engines, except the largest which was distinguished by a very ingenious arrangement to facilitate starting. This arrangement consisted, first, of means for modifying the action of the exhaust cam in such a way that the compression period was, temporarily, practically eliminated, and, secondly, of a means for obtaining the instant ignition of the gas. The igniting means made use of a lucifer match head which was fixed to the end of a small rod inserted into the gas chamber. A hammer held by a trigger was attached to the cylinder head and when released struck the match head and ignited the charge. Thwaites and Carbutt, of Bradford, had intended to show a Clayton noiseless gas engine, but could not get it ready in time. It resembled the Otto engine, we said, except that it had circular instead of sliding valves. Mr. Turner, of St. Albans, exhibited a vertical water-cooled gas engine. Its most defective point was the large amount of gas consumed solely for effecting the ignition of the charge. As shown at Kilburn, it used at least twice as much gas for ignition purposes as for the production of power. The most scientific labourer at the production of an efficient gas engine was, we said, Mr. (the late Sir Dugald) Clerk, who showed two engines on the stand of Thomson, Sterne and Co., of Glasgow. One of these engines was of an entirely new design, but as the foreign patents relating to it had still to be completed, we could say little about it. The ignition arrangement, we said, consisted of a small platinum box or cage situated in the ignition port. A current of gas and air from a reservoir was passed over the platinum cage which in about half a minute reached a white heat. Mr. Handyside exhibited a vertical engine which was really a hot air engine, worked with petroleum vapour, and Lewis Simon and Son, of Nottingham, showed a gas engine which we had previously described. The manufacture of gas engines, we wrote in conclusion, promised to become a very important branch of engineering, and if the consumption could be brought down to 10 cubic feet per horse-power-hour—Clerk had already brought it down to 15 cubic feet—the steam engine for moderate powers would no longer be the most economical motor.

Pencil Portrait No. 20

SIR FRANK E. SMITH, G.B.E., F.R.S.

UNIV. OF WICH.

DRAWN FOR THE ENGINEER BY ELLIOTT & FRY

L.M.S. Oil-Electric Shunting Locomotive

IN the accompanying engravings we illustrate one of twenty new oil-electric 350 B.H.P. shunting locomotives for the London, Midland and Scottish Railway. These locomotives, some of which are already in service and the remainder in course of erection at the company's Derby locomotive works, are built to the general design and requirements of the chief mechanical engineer, Mr. W. A. Stanier. The power equipment, consisting of oil engines and electrical equipment, was supplied by the English Electric Company, the oil engines being manufactured in that company's Rugby works, and the electrical equipment at the Bradford works. The mechanical parts, the frames, tanks, and cabs were constructed at the L.M.S. Derby works.

350 B.H.P. OIL-ELECTRIC SHUNTING LOCOMOTIVE

Designed for general shunting duties and for intensive "hump-shunting" at selected marshalling yards, this type of locomotive and the design of its equipment have been developed through the experience obtained with oil-electric shunting locomotives already in use on the company's system; in fact, when the twenty new locomotives are completed, the fleet of large oil-electric locomotives will total forty-two in number. It is interesting to note that several locomotives to the new design have already been put into service successfully at Toton Down sidings in the Midland Division, where an important mechanisation scheme was brought into operation recently.

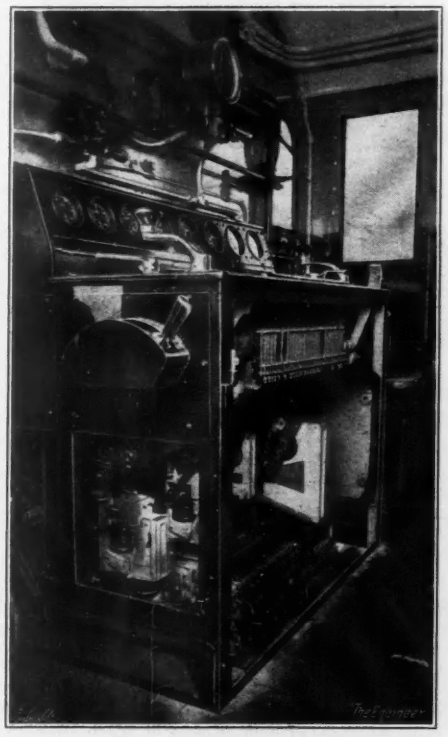
As can be clearly seen in the engraving showing a general view of the locomotive, the drive is taken to the six-coupled wheels through a jack shaft and connecting-rods from a single traction motor, driving the jack shaft gear wheel through a reduction gear. The jack shaft itself is arranged between the middle and trailing wheels. The principal dimensions and characteristics of the locomotive are tabulated herewith :—

Continuously rated engine power	350 B.H.P.
Maximum tractive effort	35,000 lb.
Wheel diameter...	4ft. 3in.
Wheel base...	15ft. 3in.
Length over buffers	31ft. 4½in.
Maximum speed	20 m.p.h.
Weight in working order	55½ tons

In order to facilitate attention to the engine and electrical equipment, the housing is divided into sections covering the oil engine, the generator, and the tractor motor, and it is bolted to the foot plating so as be easily removable. Inspection doors are provided on each side of the housing and there is a sliding roof over the engine, so that cylinder heads and pistons can be readily inspected. The fuel tanks are situated between the motor and the driver's cab. Arranged outside the frame, as in steam locomotive practice, the wheels are provided with springs above the top of the axle-box with links in tension. The wheel base has been designed to be small, to enable sharp curves to be negotiated, and the central axle is allowed ½in. end play for the same reason.

Most of the horizontal and vertical frame stretchers are of fabricated construction. Carried on girders attached to the main frames is a three-point suspension cradle for the engine and generator unit, arranged with two pedestals at the generator end, and one at the front end. Rubber pads are fitted between the pedestals and the supports to absorb vibration. Coupled wheel axle-boxes follow the standard practice in general design, the oil being supplied on the horizontal centre line of the journal from auxiliary oil boxes, which also feed the axle-box slides. Removable underkeeps and oil pads are fitted underneath the journals.

Bronze bearings, split vertically, with white metal linings on the journal and facings, carry the jack shaft. Made in the form of a steel casting, the axle-boxes for the jack shaft are split on the longitudinal plane and are wedged tightly into the jack shaft horn blocks. Lubrication is effected by a rotary pump driven by the traction motor through a reduction gear. The jack shaft gear wheel is situated on the left-hand side of the engine in a totally enclosed position in a grease-tight casing, and care has been taken in designing the seals for the gear wheel, so that it is impossible for grease to be lost during shunting operations. Of I section, the connecting-rods are bifurcated over triangular coupling-rods to which the driving rods are connected by spherical joints.



CAB WITH SWITCHGEAR UNCOVERED

Power is obtained from a six-cylinder four-stroke English Electric oil engine, which is continuously rated at 350 B.H.P. at 680 r.p.m. For controlling the engine speed, either of two controller handles may be used. They act on solenoid-operated valves, which admit lubricating oil under pressure to cylinders incorporated in the governor. Both circulating water and engine lubricating oil are cooled in a radiator mounted in front of the engine. For circulating air through the radiator, a fan is driven by belt from the front of the engine, the air being exhausted through louvres in the housing. Also situated behind the radiator, in the roof of the housing, is an engine exhaust silencer. A separately driven pump supplies lubricating oil to the engine and circulates it through a separate section of the radiator. Thermometers are provided for measuring the lubricating oil and cooling water temperatures.

Directly coupled to the engine is a 250-kW direct-current generator, supplying current to the single traction motor, which finally drives the jack shaft through double reduction spur gearing. On light loads the engine is prevented from attaining excessive speeds by the action of a mechanical governor, but on heavy loads a special arrangement of the electrical control system, termed by the English Electric Company "torque control," limits the power taken by the main generator to a value within the capacity of the engine, in order to prevent overloading. As the master controller is "notched up," the speed of the traction motor increases with the engine speed, by reason of successive increases in the voltage of the main generator. There is also on the master controller a second control lever which enables a fine variation in speed to be made on each notch.

An 80-volt battery, mounted in front of the fuel tank on either side of the frames outside the housing, supplies current for various services. One of its chief functions is to provide a means of starting the oil engine by energising the main generator and causing it to run as a motor until the engine fires. Push buttons are provided so that the engine can be started or stopped from the driving cab or the engine room. The battery also supplies the control system, the lights and the main generator field winding. Charging current is automatically obtained from the main generator when the engine is running at idling speed.

To supply compressed air for the brakes and other services, a compressor is mounted on the main generator and driven therefrom by belt. On certain of the locomotives an exhauster is provided for testing the braking systems of coach stock. This exhauster is driven by a motor which takes its supply from the battery. Westinghouse straight air and hand screw brakes are fitted, with double brake blocks on each wheel, worked through compensated levers and controlled by a self-lapping driver's brake valve. Air from the Westinghouse system is also utilised for operating the whistle and for the sand boxes, situated in front of the leading and behind the trailing wheels.

The main fuel tank, situated between the cab and the generator housing, has a capacity of 586 gallons and mounted above it is a 75-gallon service tank, from which fuel oil is led to the injection equipment.

Two control handles and two brake handles are provided on the control desk in the cab, and handles for the sanding and the whistle gear are situated on the cab front. Other cab details include :—Hand screw brake, cab heater, electric food cooker, speedometer, adjustable tip-up seats on each side, and drop windows in the cab sides and doors.

UNION STATION AT LOS ANGELES

THE railway situation in America has not been favourable to the desired construction or reconstruction of large passenger stations, but conditions at Los Angeles, in California—with three main lines at street level—have resulted in the construction of a fine new joint or union station at a cost of some £2,200,000. All the lines are now elevated about 18ft. above the streets, and two old stations have been abandoned. The city, with a population of 1,400,000, has grown enormously in recent years, and finally secured the track elevation and joint station by concerted action of the three railways, the plans being worked out by a committee composed of representatives of these lines. The cost is distributed in the ratio of 44, 33, and 23 per cent., based mainly on traffic conditions. It is a terminal or dead-end station, with six approach tracks connecting with sixteen platform tracks and eight platforms, while six additional tracks serve for baggage, mail, and express cars. A feature unusual in American practice is that three groups of platform tracks have each a third or middle track with crossover connections, thus permitting the arrival locomotives to be released while the trains are at the platforms. The station building is two stories high, and, as usual, a spacious waiting room, 140ft. by 80ft., is its main feature. A transverse subway extends under the tracks with ramps of 1 in 8 inclination to the platforms. The tracks, laid with 112 lb. rails, are 13ft. between centres or 31ft. across the platforms, which are 21ft. wide and 1000ft. to 1500ft. long. There is no train shed, but each platform has a shelter roof carried on central columns, 80ft. apart. The main signal cabin has 138 levers, of which 54 control 104 electro-pneumatic switch machines and 50 control 83 interlocking signals. Dwarf signals are used mainly, showing red, green, and yellow.

Dunton Pumping Station

ON July 4th last, there was opened by Lord Luke of Pavenham the new Dunton pumping station of the Biggleswade Water Board. The pumping station has been built to meet the increasing call for water from the Board's area and the water is pumped to existing service reservoirs.

The decision to seek an additional source of water supply was taken in 1936 and various sites were considered. Sinking of test wells into the greensand under the Dunton site revealed that a satisfactory yield would be available, and arrangements were consequently made for the provision of pumping machinery at that site. A contract was awarded to George Stow and Co., Ltd., the firm which undertook the test boring, for the sinking of additional bore-holes, and contracts were entered into with Wrights (Langford), Ltd., for the erection of the necessary buildings, and with W. H. Allen, Sons and Co., Ltd., and Permutit Company, Ltd., for the necessary pumping and filtering plant. There are in all four 14in. bore-holes carried down to depths between 230ft. and 250ft. below the surface. These bore-holes are set at considerable distances apart, and it was consequently decided that electricity would be the best motive power to employ for driving the pumps. The engraving, Fig. 1, shows the general disposition of the buildings. The large building on the right houses the electric generating and filtering plant. Three out of the four square shaped buildings housing electric motors and bore-hole pumps are also visible in the engraving. Messrs. Binnie Deacon and Gourley, Westminster, were the consulting engineers.

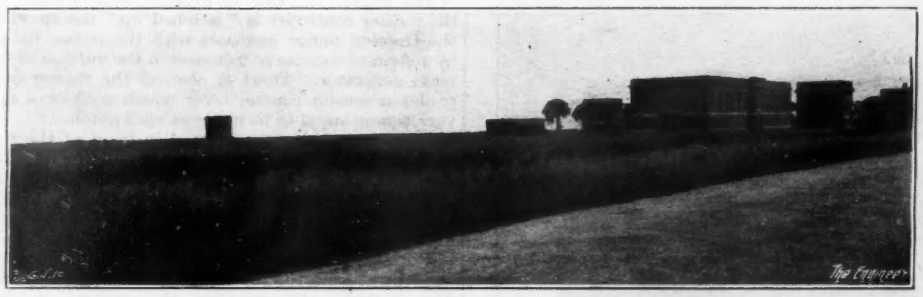


FIG. 1—GENERAL VIEW OF DUNTON PUMPING STATION

The main building is 131ft. long by 38ft. wide, and contains, besides the generator and filtration halls, an entrance hall, workshop, messroom, and store. At the back of the building there are underground fuel storage tanks accommodated in a pit, 40ft. long by 24ft. wide and 11ft. deep, and a concrete cooling water pond. The power plant consists of four two-cylinder oil engines, driving 85-kW, 440-volt, D.C. generators and running at 275 r.p.m. They have been designed to conservative standards to meet the desire of the Water Board for machines that would give long and trouble-free service. A section through the generator hall is reproduced in Fig. 2, and shows the general arrangement of an engine and the fuel and exhaust systems. Compressed air for starting purposes is provided by two small compressor sets, one motor driven for use when the main generators are running, and one engine driven. The air is stored in a number of cross-connected air receivers. Cooling water is pumped from the cooling pond to overhead tanks and flows through the engine jackets by gravity back to the pond. The service fuel tanks provide twenty-four hours' supply, and fuel is transferred to them from the main storage tanks through two De Laval centrifugal purifiers, each of 60 gallons per hour capacity. Small coil heaters fitted to the exhaust of each engine warm the lubricating oil, which is continuously passed through "Streamline" filters. Exhausts from the engines are led vertically downward and beneath the floor as shown in the drawing to an exhaust chamber built as an annexe to the main building. Here, as illustrated in Fig. 3, there is an exhaust heat boiler which can be utilised to heat water for warming the pumping station. There is a common exhaust discharge into an expansion box followed by a Burgess type terminal silencer and uptake pipe.

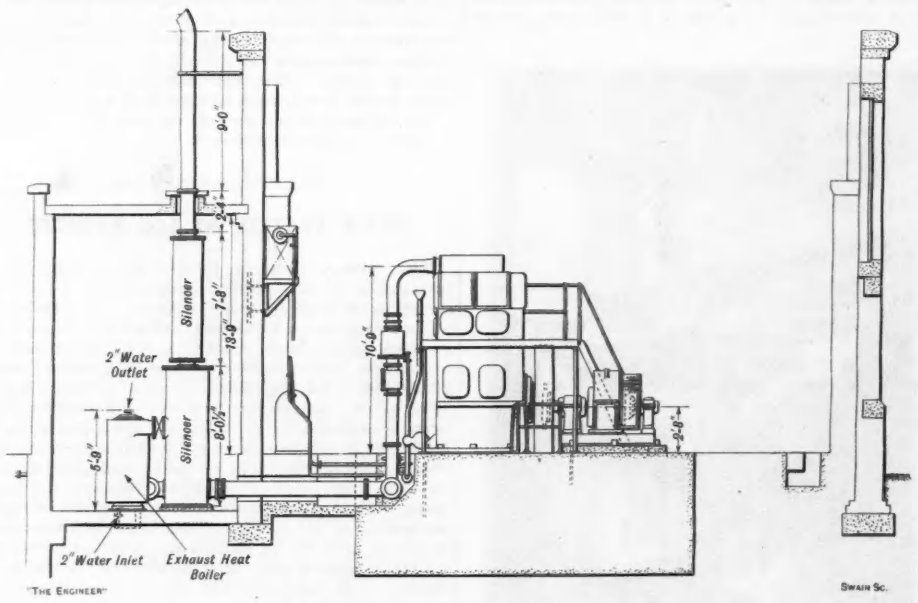


FIG. 2—SECTION THROUGH GENERATOR HALL

A switchboard, illustrated in Fig. 6, distributes the power. It has seven panels, the first four of which are each fitted with a double-pole circuit breaker, double-pole main and equaliser switch ammeter, voltmeter, integrating watt-hour meter, and a shunt regulator. Two panels each serve two of the bore-hole pumps, and the final panel is fitted with switches for the control of the auxiliary motor and other minor circuits. Control gear for the bore-hole pump motors is arranged alongside the main switchboard. Shunt regulators permit the speed of the pumps to be varied between 1350 and 1520 r.p.m. The starters are interlocked with pressure switches arranged to stop any motor in the event of failure of the supply of water to the transmission shaft and pump bearings.

Two of the bore-hole pumps are designed to deliver 18,000 g.p.h. each, lifted from a depth of 140ft. and discharged against a total head from well level of 404ft. at a speed of 1450 r.p.m. The other two pumps have a capacity of 14,400 g.p.h. under the same conditions. Each unit consists of a seven-stage, conical-flow bore-hole pump at the bottom, and a four-stage force pump situated just below the well-head girders. The larger pumps are driven by 62 B.H.P. vertical D.C. motors (Fig. 4), and the smaller by similar 50 B.H.P. machines. The rising mains are 8in. internal diameter and the transmission shaft, which is carried in lignum vitæ bearings, is 2in. diameter. The entire shafting is enclosed in a steel shaft tunnel to which clean water is supplied under a pressure in excess of that in the rising main. This water is taken from the force pump discharge and passed through filters before entering the shaft tunnel. Normally, two engines will be operating together to supply current to the two larger pumps and one of the smaller. Under these conditions the guaranteed consumption of 0·712 lb. of fuel per W.H.P. hour overall has been readily attained on test.

The water pumped from the bore-holes contains a certain amount of iron, the quantity being somewhat variable, but in the region of 0·08 parts per 100,000. In order to remove this iron the water is pumped through a battery of eight Permutit "Permiron" vertical type, iron-removing pressure filters (Fig. 7).

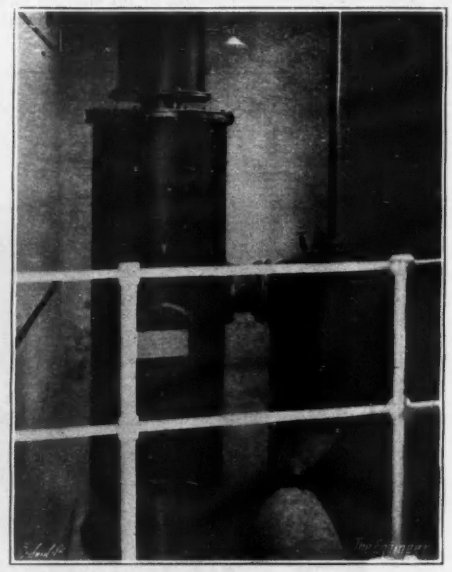


FIG. 3—EXHAUST SILENCER AND WASTE HEAT BOILER

Each is 9ft. diameter by 6ft. high on the square, and when pumping at a flow of 50,000 gallons per hour the rate of filtration is 98 gallons per square foot per hour. These filters are similar in construction to the ordinary sand filters commonly employed for the removal of suspended matter, but the filter shells are made somewhat deeper than is usual with ordinary sand filters and they operate with an air space in the top of the shell. The incoming water is sprayed through this air space and the oxidisation of the iron which takes place brings it into the form of solid particles of iron oxide, which can then be retained by the sand bed. The necessary air to promote oxidisation is supplied from a small reciprocating compressor installed in duplicate, and is injected into the filter inlet pipe so that it enters along with the water. An automatic air release is provided to allow for the escape of excess air, and a water level gauge enables the operator to see the actual level of water in the filter.

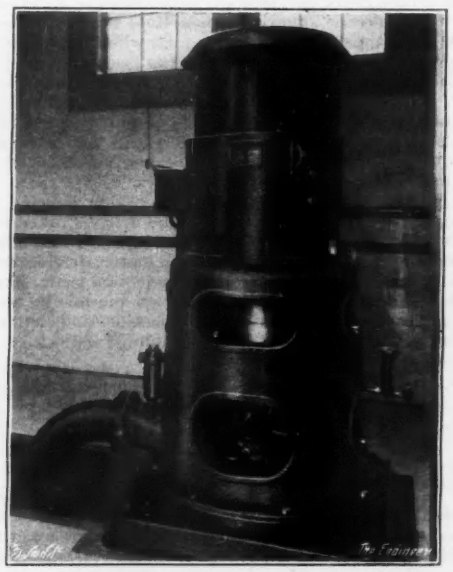


FIG. 4—PUMP MOTOR

The process of oxidisation followed by passage of the water through the sand bed will usually remove about 90 per cent. of the total iron present in the water, but to ensure the reduction of the final iron content to a negligible figure the sand bed also contains a quantity of special iron-removing material known as "Permiron," an intensive oxidising agent

DUNTON PUMPING STATION, BIGGLESWADE

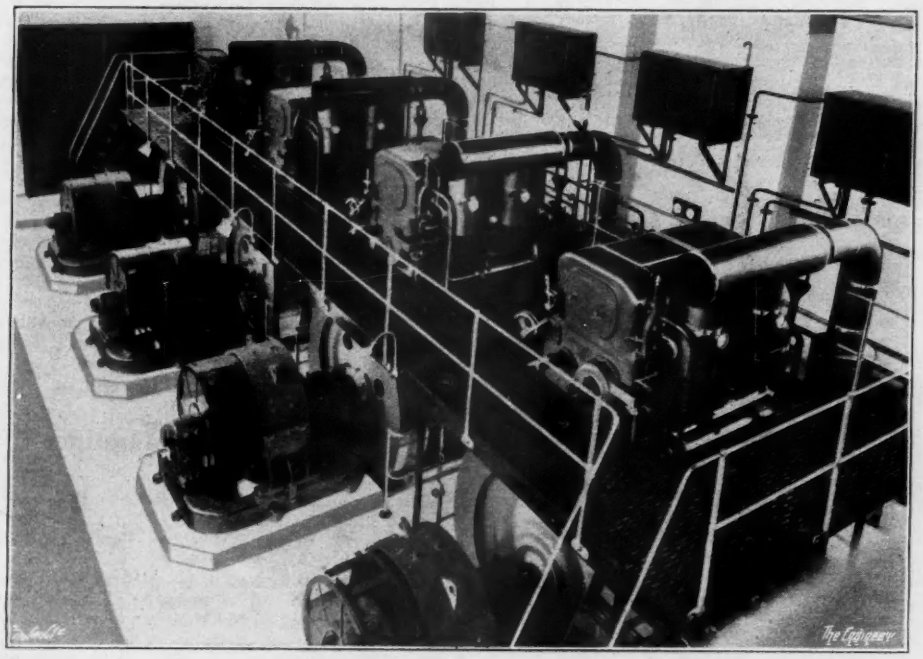


FIG. 5—OIL ENGINE GENERATING SETS

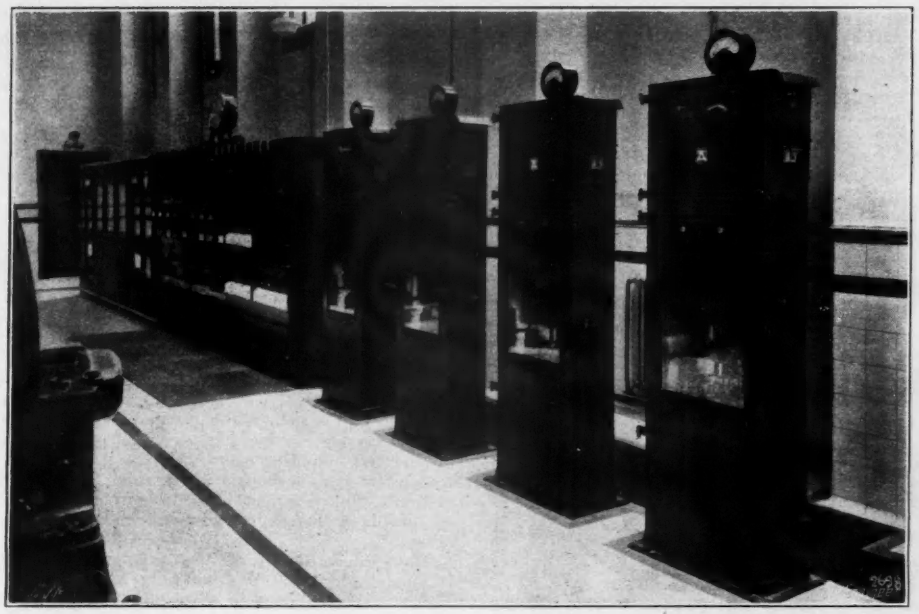


FIG. 6—PUMP CONTROL GEAR AND MAIN SWITCHBOARD

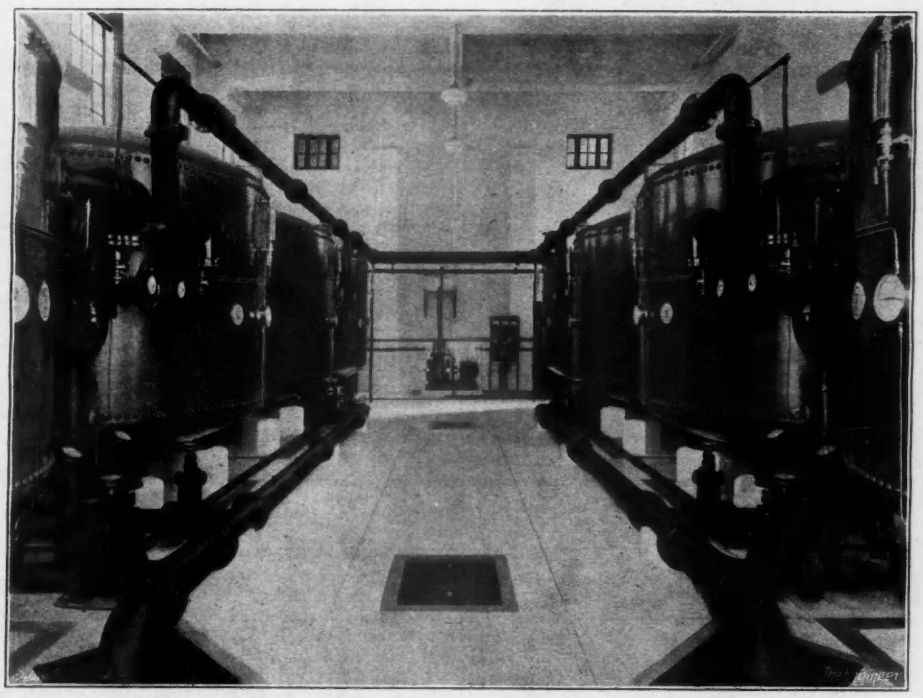


FIG. 7—FILTERING PLANT

which oxidises out any traces of iron remaining after the spraying process. The material requires no regeneration or attention other than the natural re-oxygenation which takes place when the filters are air scoured during the cleansing process.

The filters are cleansed by the application of compressed air for a period of three to four minutes, followed by a reverse flow of filtered water drawn from the filtered water main which passes through the bed in an upward direction and carries away the loosened iron oxide and any other impurities to waste. The necessary air is supplied from a rotary air blower driven by an electric motor, and is first passed through an oil-eliminating filter in order to avoid any contamination of the underdrains or filtering media by oil.

The efficiency of the treatment is indicated by the following typical figures of iron content for the crude and filtered water:—Total iron (as Fe) parts per 100,000: Crude water, 0·08; filtered water, 0·0043.

And So To Hell*

TEMPERATURES up to 4500 deg. Fah. are now being used. These are the highest temperatures ever used effectively with large amounts of controlled heat. Still higher temperatures could be produced by the Harvard metallurgists who developed the furnace employed, but no refractories are known that will keep such heat within a closed space; even thorium oxide begins to break down. "A billion degrees Fahrenheit" has been reached, but only in a gas-filled tube, remotely related to the neon light, but much more highly evacuated. Such "temperatures" mean nothing in terms we comprehend—certainly not in warmth. With these and other recent advances in the achievement of high temperatures, a re-examination of the effect of different degrees of heat now becomes of interest.

We live in a placid domain of room temperature, whose chemistry is the luke-warm test tube, the preparation of many "fine" chemicals, and the biochemical processes of life. Anything can happen, but little startling does unless we make it. Were it not for the extraordinary reactivity which water confers on all with which it comes in contact, this would be a stagnant world. Sluggishness at the temperatures about us has some real advantages, however. Since all reactions are slow, the chemist can choose the one he wants and speed it up without accelerating the others. Moreover, biochemistry requires just these temperatures for the very rapid reactions of the large molecules which make life go. At lower temperatures these reactions are too sluggish to support life; at higher temperatures these large molecules break down.

Vague stirrings of further molecular awakening occur at the temperature of the kitchen range. Egg white undergoes structural modifications. Starch becomes digestible. Some vegetable oils become good varnishes. Fats can be converted into soap.

In the uncomfortable torrid zone of 400–800 deg. Fah., the range of most heavy chemical manufacture, some spontaneous reactions become active, particularly those of interest to the local fire department. Chemical reactions become less manageable, tending strongly to go in several directions at once, but by selective catalysis can be guided, at least to a limited degree. Moreover, the reactions tend to come to a halt or even go into reverse as opposing forces tend to balance in chemical equilibrium. By shifting pressures, to move the reaction into a zone of more favourable conditions, as in high-pressure synthesis of ammonia, equilibria also can be controlled to some extent. Complicated structures break down into simpler units; oil cracks to gasoline; nitrogen and hydrogen unite to form ammonia; carbon monoxide combines with hydrogen to form methyl alcohol, gasoline, or paraffin, according to the catalysts and pressures used.

At about 800 deg. Fah. cast iron can just be seen to glow faintly red in the dark. At 2200 deg. Fah. it is bright yellow. When raw materials are brought into a hot zone in this temperature range, all reactions occur practically instantly, but none to the exclusion of others. Neither by catalysts nor by manipulation of pressures may more than limited control of the reaction be achieved, but practically only by varying the rates at which raw materials are brought into the hot zone and the various products of the reaction withdrawn. This is the temperature range of metallurgical processes. Lead, zinc, and copper are reduced from their ores. Only the most rugged chemical compounds remain—water vapour, carbon monoxide, hydrochloric acid, among the familiar gases; oxides and carbides, among the refractory solids. More fragile substances—ammonia, for example—have almost completely broken down.

Near 3000 deg. Fah. iron melts, and sand combines with soda and lime to form glass. At about 4000 deg. Fah. iron begins to vaporise and coke reacts with lime to give calcium carbide, with sand to give carborundum, and with itself to give graphite. At

* From *Industrial Bulletin* of Arthur D. Little, Inc., June, 1939.

somewhat higher temperatures new chemical compounds, explosive or incapable of existence at lower temperatures, become important. At temperatures a little lower than that of the sun (12,000 deg. Fah.) they have become dominant and chemistry takes on a new simplicity; the compounds are such gases as monoxides, or monohydrides of carbon, nitrogen, or sulphur. At temperatures somewhat higher than the sun, these, too, fall away into atoms and ions. Gases become brilliantly luminous conductors; we are at 50,000 deg. Fah. in the chemistry of the neon sign.

At a "temperature" of about 400,000,000 deg. Fah. a completely new type of reaction begins to take place at observable rates. Just as at a lower temperature large molecules broke down to smaller and smaller molecules as the temperature rose, and ultimately to their constituent atomic ions, so some atoms break down into others, lead to gold, for example, or magnesium to sodium and hydrogen, and ultimately to their constituent electrons, protons, and the rest of the growing family. In this atomic chemistry we run through the same familiar series of controlling forces we encountered with molecular chemistry, with rates of reaction the predominant factor at "low" temperatures and equilibria again controlling as temperatures advance. And so it goes, as the temperature goes up, until we get where the cosmic rays come from.

Here chemistry enters a third phase, whose nature can only be vaguely guessed. When we ultimately go to collaborate with the gentleman of trifurcated tail, it will be interesting, indeed, to see what he is making.

A Large Industrial Locomotive

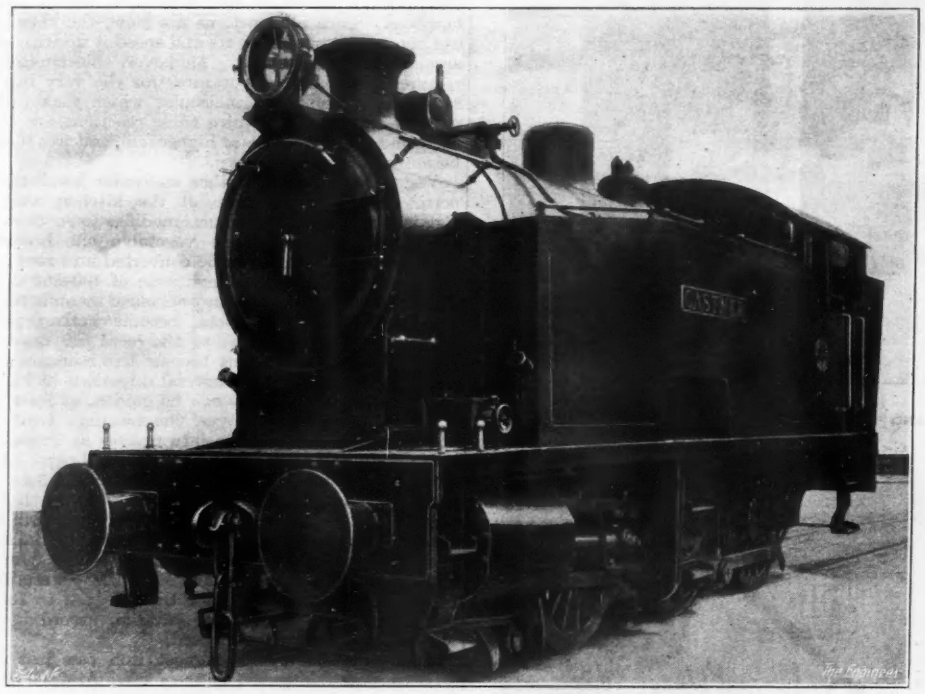
IN the accompanying engraving is shown a large 0-6-0 locomotive recently completed by Andrew Barclay, Sons and Co., Ltd., Kilmarnock, for service at the Runcorn works of Imperial Chemical Industries, Ltd. This engine, which is among the largest to be built by the company for purely industrial purposes, weighs 47 tons 18 cwt. empty and 59 tons in full working order.

It is of the side tank type, with outside cylinders, 19in. diameter by 26in. stroke. The boiler, which has a working pressure of 180 lb. per square inch, has an overall length of 19ft. 9in., the barrel part being 4ft. 8in. outside diameter. The internal fire-box is 5ft. $4\frac{11}{16}$in. long, 4ft. $2\frac{1}{4}$in. wide, and 5ft. $4\frac{3}{4}$in. and 4ft. $10\frac{3}{4}$in. high. There are 252 tubes in the boiler, which has a heating surface of 1124 square feet, the total heating surface, including the fire-box, being 1236 square feet.

Although the engine has an overall length of 29ft. 10in., the wheel base is only 11ft.; it is thus able to negotiate curves of quite small radii. Its tractive effort at 85 per cent. boiler pressure is 29,900 lb.

The tank has a capacity of 1450 gallons and the bunker holds 2 tons of coal.

A Wakefield mechanical lubricator supplies oil to the cylinders, axle-boxes, piston-rods, and steam brake. Bronze bushes are fitted in the principal bearings and valve gear. The axle-boxes have heavy liners of bronze on the faces next the wheel and axle-box guides.



0-6-0 INDUSTRIAL LOCOMOTIVE

Dough-Mixing and Kneading Machine

THE illustration herewith shows a new type of heavy-duty elliptical dough-mixing and kneading machine, designed and constructed by James Cruickshank, Ltd., of Edinburgh. This machine is made in sizes from $\frac{1}{2}$ to $2\frac{1}{2}$ sacks' capacity, all provided with open revolving bowls, and arranged for belt or motor drive.

Of an entirely new design, the mixing arm is made of high-grade steel, and is U-shaped. By reason of its shape, it is constantly immersed in the dough, and it is therefore claimed that the maximum kneading action is obtained with low power consumption. With the more usual type of single-arm kneader the arm only mixes and kneads the dough through half of its revolution, for while it is passing over the bowl there is no work done. The same remarks apply to machines with two separate mixing arms, for they also are out of the bowl, and therefore not working, for between one-quarter and one-half a revolution. With the new design, however, we are informed that one or other of the forks of the U-shaped arm is always at work in the dough, and both work during more than half a revolution.

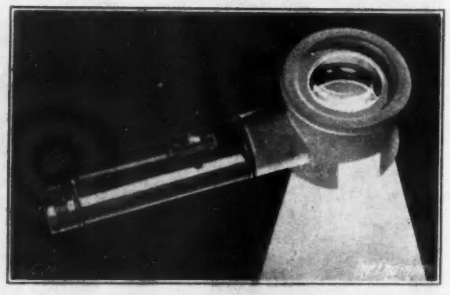
DOUGH-MIXING AND KNEADING MACHINE

It will be noted from the engraving that the mixing arm works to one side of a central column, thus enabling the dough to be removed, if need be, safely and easily from the other side of the bowl while the machine is working. Furthermore, it is claimed that the arms have a gentle action on the dough and therefore do not "tear" or overheat it. It is also stated that the "proving" period required is considerably reduced. When finished, the dough forms a continuous ring, and not a solid mass, so assisting the operation of "cutting out" and its removal from the bowl.

Cast iron is the material used for the bowl, and the one shown in the illustration is of full $2\frac{1}{2}$ sacks' (280 lb. per sack) capacity. The whole of the interior is machined and polished to give a hard, glass-like surface, to prevent dough from adhering to it. Two scrapers are fitted to keep the bowl clean, and to facilitate the removal of the dough from the bowl. We are informed that hand scraping is unnecessary; in fact, the manufacturers state that this feature can save twelve hours a week of labourers' time. The bowl shaft is carried on Timken tapered roller bearings, and the whole unit is mounted on a carriage, the wheels of which are fitted with Timken tapered roller bearings also, for convenience in handling the assembly. Gearing has been reduced to a minimum, and is of nickel-chrome steel, machine cut. The main drive to the mixer arm is through the medium of a worm and worm wheel, and all the shafts are of ground high-tensile steel mounted on Timken tapered roller bearings. The approximate speed of the main spindle carrying the mixing arms is 20 r.p.m., equivalent to 40 strokes per minute of the two forked arms, during which time the bowl makes five revolutions, corresponding to 300 strokes of the two forks of the mixing arm through the dough in seven minutes.

An Illuminated Magnifier

THE illuminated magnifier shown in the accompanying illustration has been brought to our notice by Mr. S. W. Partington, of 96, Gloucester Road, S.W.7. Although it was originally designed for use in the medical profession, it has engineering applications and can be used in awkward positions where the usual microscope cannot be employed. For the examination of worn parts, finishes, flaws, and the surfaces of sheets, &c., it is claimed to be of considerable value. Minute examinations, upon which much often depends, can be carried out with ease by engineers and metallurgists alike. The instrument is also claimed to be of assistance to many others, such as paper makers, engravers, watch makers, textile experts, geologists, &c. It comprises an illuminated cylinder made of white bakelite fitted with a lens system and an electric torch. As the lens system is 2in. in diameter a considerable area can be examined, and a very powerful magnification is obtained.



ILLUMINATED MAGNIFIER

The illumination from the torch is concentrated in the cylinder to a power 400 times that of daylight and affords visibility to the extreme edge of the observation field. Light driven into the surface of the specimen reveals the depths of fractures and fissures with a clarity said to be unobtainable by other means. An aperture at the side of the cylinder enables the user to work upon the object while it is illuminated, and under the high magnification, while a transparent celluloid "magnicrometer" provided with each instrument is claimed to make it possible to take measurements to within 1/256th of an inch. The daylight electric bulb is made by the B.T.H. Company, and, like the battery, is of standard size; but batteries of the kind supplied with the instrument are said to have an exceptionally long life. We are told that the magnifier is in use in 900 hospitals, and recognition of its value in other directions has been acknowledged by an invitation by the Royal Geological Society to exhibit it at its conversazione.

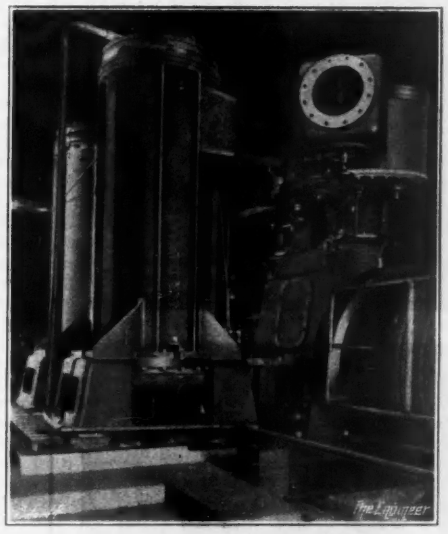
Hard-Wearing Screen Cloth

IT is common knowledge that one of the troubles experienced in practice in using screening processes is the rapid wear of the screen cloth. At short intervals of time the machine needs to be shut down for the renewal of the screen with a consequent loss of time and output and continually recurring cost of replacement. The Harristeel Products Company of New York, for which Morden McDonald and Co., of 36-38, Victoria Street, London, S.W.1, are sole agents in this country, has recently produced a steel which, when used in screen cloth, is claimed to provide a much-increased life. This steel has the very high tensile strength of 225,000 lb. per square inch and a Brinell hardness number of 450 to 550. Nevertheless, its ductility is such that wires or rods can be bent around their own diameters, it is claimed,

without fracture. Cloth made from this material is precrimped and hand woven to obtain that accuracy of opening and tight intersections which are so necessary. It is made in a full range of sizes from $\frac{3}{16}$in. to 5in. square in various constructions, including those known as blindless, "wabbly" non-plug, non-spreader, scalper, flat top, and blast-furnace smooth top, and can be designed to fit all makes of screens. Morden McDonald and Co. have supplied us with the following figures relating to a large steel works in this country. It was found that ordinary screens required replacement after periods averaging about eleven days, during which about 10,000 tons of blast-furnace coke was passed over them. With the new cloth an output in excess of 60,000 tons has been achieved before replacement has become necessary. The new cloth, it hardly needs to be added, is expensive; but its manufacturers claim that its life is more than sufficiently long to justify the extra cost without taking into account savings brought about by the reduced time lost in making replacements.

Air Compressors for the U.S.S.R.

AMONGST orders recently completed by J. Browett-Lindley (1931), Ltd., of Letchworth, Herts, for air compressors is a large contract for Machinoimport, U.S.S.R., comprising twenty-three machines—ten having a capacity of 4000 cubic feet per minute and thirteen of 2100 cubic feet per minute, when delivering at a pressure of 120 lb. per square inch. These machines are of the firm's standard two-stage, double-acting, crosshead type, and are arranged for direct



LARGE AIR COMPRESSOR ON TEST

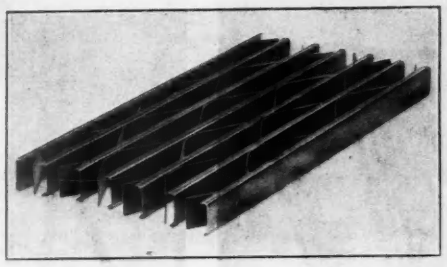
coupling to electric motors. The former group is fitted with intercoolers and aftercoolers, while the thirteen smaller machines are equipped with intercoolers only. We are informed that these compressors are to be distributed among large industrial concerns throughout the U.S.S.R.

It is interesting to note that the firm increased its compressor testing equipment some time ago, partly with a view to dealing with this order, by installing a vee rope drive, which is now believed to be the largest of its kind in the world. The driving motor has an output of 1000 B.H.P., and is of the auto-synchronous type. Compressors of the largest sizes can be tested under full load conditions with this equipment at the firm's works.

The compressors were built to the specifications of the Russian engineers, and inspected by them before despatch. The accompanying illustration shows one of the 4000 cubic feet per minute compressors being tested at the works. The large cylindrical containers in the foreground are the aftercoolers.

Light Steel Grill Flooring

IN the accompanying engraving we illustrate a new type of light steel grill flooring which has recently been placed on the market by Allan Kennedy and Co., Ltd., of Vulcan Street, Middlesbrough, the makers of "Safetread Steel Flooring." The new flooring is to be known as "Safetread Grillage," and it is made up from light steel strip folded into channel section, and fabricated in panels by interlacing the channels with corrugated flat strip of the same gauge, which is spot welded at regular spacings. It is claimed that this new type of grating, which is the subject of a patent application, is both light and remarkable in strength. It has been devised by the firm to meet the need for a grating for walkways and gangways up to a width of, say, 2ft. 6in. Up to spans of these dimensions it offers, the makers claim, a reduction in weight of the order of 33⅓ per cent. compared with the type of grating usually supplied for walkways and gangways, but with an equivalent load-carrying capacity. The ends of the channel sections are chamfered in order to accommodate the radius in the corner of the angle bar supports, thereby providing a snug fit, and eliminating any necessity for welding on side or margin flats. The panels of grillage are formed with a corrugated bar at one end, which is drilled with two holes, by means of which it is bolted to the



STEEL GRILL FLOORING

adjoining panel. By this means a uniform pattern is maintained, to the end of a gangway, at which point the final channel is fitted in the opposite way, thereby forming a neat finish. "Safetread Grillage" can be supplied in two different depths, one 1in. deep, for spans between 2ft. 3in. and 2ft. 6in., and ¾in. deep for spans from 1ft. 6in. to 2ft.

The Quarter's Shipbuilding Returns

THE statistics issued by Lloyd's Register of Shipping regarding merchant vessels under construction at the end of June last show that in Great Britain and Ireland there is an increase of 194,552 tons in the work in hand as compared with the figures for the previous quarter. The present total of tonnage under construction—791,455 tons—is, however, less by 245,618 tons than the tonnage which was being built at the end of June, 1938. About 108,000 tons—13·7 per cent. of the tonnage now being built in this country—are intended for registration abroad or for sale.

The tonnage now under construction abroad*—2,067,837 tons—is 38,927 tons less than the work which was in hand at the end of March last. The leading countries abroad are: United States of America, 391,824 tons; Germany, 347,832 tons; Japan, 308,849 tons; Italy, 224,616 tons; Holland, 223,381 tons; Sweden, 160,620 tons; and Denmark, 122,440 tons. Of the tonnage being built abroad, about 536,000 tons, or 25·9 per cent., are intended for registration elsewhere than in the country of build or for sale, including 171,113 tons for Norway, and 92,748 tons for Great Britain and Ireland.

The total tonnage under construction in the world amounts to 2,859,292 tons, of which 27·7 per cent. is being built in Great Britain and Ireland, and 72·3 per cent. abroad. The quarterly total for the world is 155,625 tons more than at the end of March last, and is higher than any recorded since March, 1938.

In Great Britain and Ireland, construction was commenced upon 402,080 tons during the last three months, this figure showing the notable increase, of 330,924 tons over the corresponding total for the March quarter. During the quarter ended June last, 137,552 tons were launched in Great Britain and Ireland, a decrease of 20,234 tons as compared with the previous quarter. Similar figures for abroad are 480,728 tons commenced, and 411,436 tons launched, showing, as compared with the previous quarter, a decrease of 176,117 tons in the tonnage commenced, and of 120,947 tons in the tonnage launched.

Steam and motor oil tankers of 1000 tons gross and upwards under construction in the world amount to seventy-one vessels of 634,665 tons—eleven steamers, of 99,448 tons, and sixty motorships, of 535,217 tons. Of these, eleven vessels of 96,210 tons are being built in Great Britain and Ireland, thirteen vessels of 125,448 tons in the United States of America, thirteen of 120,500 tons in Sweden, eight of 70,862 tons in Germany, seven of 61,775 tons in Italy, and six of 50,750 tons in Holland.

The vessels being built in the world at the end of June include fourteen steamers and thirty-two motorships of between 8000 and 10,000 tons each; thirteen steamers and forty-three motorships of between 10,000 and 20,000 tons; two steamers and two motorships of between 20,000 and 30,000 tons; and three steamers each exceeding 30,000 tons.

Of the 791,455 tons under construction in Great Britain and Ireland at the end of June, 357,995 tons consisted of motorships, while at the same date the motorship tonnage being constructed abroad, 1,266,712 tons, was 477,705 tons in excess of that of the steamers.

Of the merchant shipbuilding in hand throughout the world at the end of June, 1,394,526 tons are being built under the inspection of Lloyd's Register. Of this total, 705,145 tons, representing nearly 90 per cent. of the tonnage being built there, are under construction in Great Britain and Ireland, while, of the tonnage being built abroad, 689,381 tons are being constructed under the inspection of Lloyd's Register.

* From Russia, no returns have been received; for Spain complete information is not available.

British Standards Institution

All British Standard Specifications can be obtained from the Publications Department of the Institution at 28, Victoria Street, London, S.W.1. The price of each specification is 2s. 2d. post free, unless otherwise stated.

BRITISH STANDARDS FOR A.R.P. REQUIREMENTS

The Home Office Air Raid Precautions Department has arranged with the British Standards Institution to prepare and issue on their behalf a special A.R.P. series of British Standards for Air Raid Precaution Purposes.

The preparation of these standards will be under the control of a special advisory committee, and in accordance with the usual practice of the B.S.I., will be carried out in the closest co-operation with Government Departments and the industry concerned.

All communications relating to this work should be addressed to the British Standards Institution, 28, Victoria Street, Westminster, S.W.1.

AIRCRAFT MATERIALS AND PARTS

The British Standards Institution has recently published the following new Specifications for Aircraft Purposes:—

A.15.—Hexagonal-headed Bolts (High-tensile Steel).—This specification is limited to bolts machined from bars and covers ¼in. to 1in. B.S.F. and Nos. 2, 4, and 6 B.A. sizes.

A.14.—Hexagonal Brass Nuts.—This specification covers ordinary nuts and thin nuts, the latter being primarily for locking purposes for turnbuckles and similar fittings.

S.P.8.—Turnbuckles (Tension Rod Type).—This specification covers the material and dimensions for turnbuckles of the tension rod type. The fitting comprises a right and left-hand threaded tension rod used in conjunction with two standard fork joints (S.P.3).

4.T.47.—Brass Tubes for Honeycomb Type Radiators for Aircraft (Revision).—The revision includes a mercurous nitrate test as a check on the tendency of the tubes to develop cracks due to the internal stresses in the hard-rolled material.

B.S.S. 5.L.3.—Aluminium Alloy Sheets and Coils (Revision); B.S.S. 2.L.38.—Aluminium Coated Aluminium Alloy Sheets and Coils (Revision).—The chemical composition of the alloy remains unaltered, with the exception that the upper limit for magnesium has been raised to 0·8 per cent. The copper used for making the alloy is to assay not less than 99·8 per cent. No alteration has been made to the mechanical properties of the material other than the substitution of a plain bend test for the 90 deg. reverse bend test for sheets or strip, 12 S.W.G. thick and thinner.

B.S.S. 3.F.50.—Eyeleted Fuselage Webbing (Revision).—The principal revision consists in the adoption of a modified method of holding the webbing in the test for the determination of the tensile breaking strength of the material to avoid erratic results due to the sample slipping in the jaws of the testing machine.

Copies of these specifications may be obtained from the Institution's Publications Department, price 1s. 2d. each post free.

FUSION WELDED AIR RECEIVERS

No. 487. This specification, first issued in 1933 and subsequently revised in 1937, has now been further revised. This latest revision was originally undertaken in order that the provisions in regard to access might be reviewed in the light of the requirements of the Factories Act, 1937. The lower limit to which the specification is applicable has been defined to exclude air receivers smaller than 9in. internal diameter, these smaller air receivers, together with pressure paint containers, being the subject of separate specifications. An important additional amendment is the omission of the provision referring to lacing straps.

ARCHITECTURAL LAMPHOLDERS FOR LAMPS

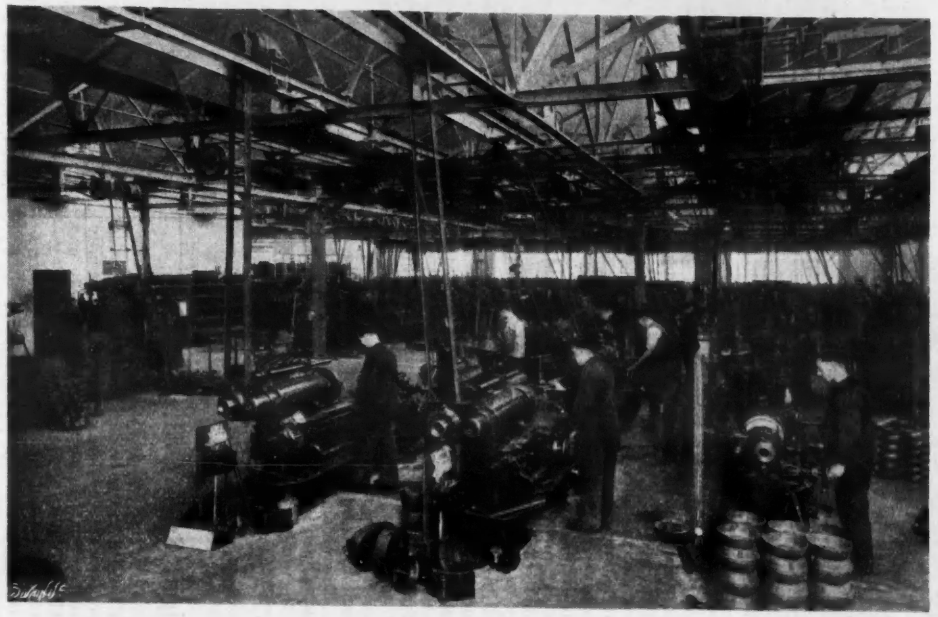
No. 841.—This new specification gives details of the dimensions of the caps for 30 mm. and 40 mm. diameter tubular lamps, and prescribes the essential requirements for the corresponding lampholders from the points of view of safety and interchangeability.

WATER HEATERS

No. 843—1939. This specification relates to thermostatically controlled thermal storage electric water heaters with copper containers from 1½ to 100 gallons capacity. In preparing it the recommendations of the Electrical Development Association were taken as a general basis. The performance tests included in the specification have been devised to ensure, as far as possible, that water heaters complying with the specification will give satisfactory performance under all reasonable conditions of use. The British Waterworks Association and the Metropolitan Water Board have co-operated closely in the preparation of the specification, and a number of clauses have been included which should facilitate the obtaining of the approval of water authorities.

NEW WORKS OF KEITH BLACKMAN, LTD

(For description see opposite page)



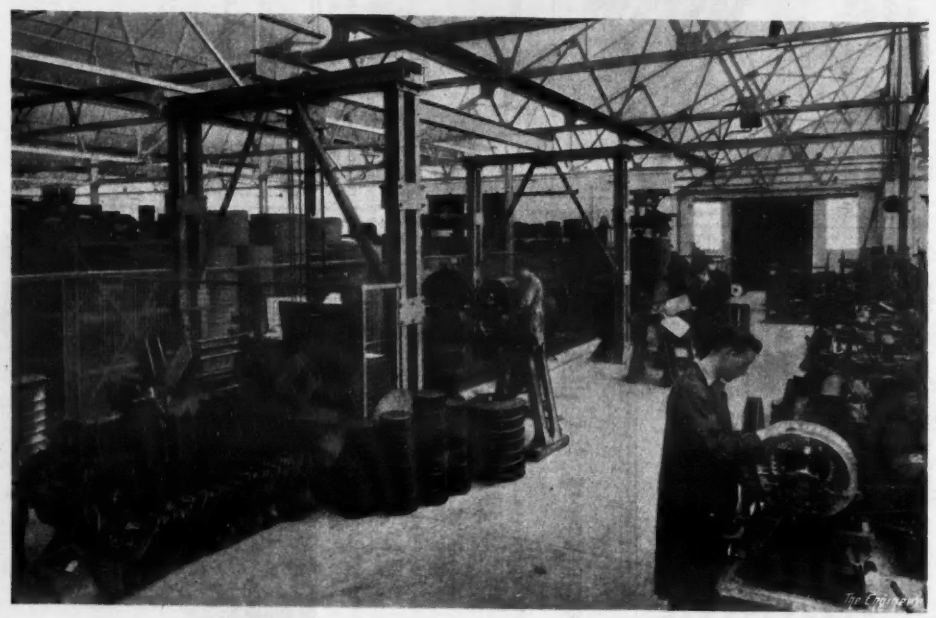


FIG. 1—POWER HOUSE

FIG. 2—ELECTRICAL TEST SHOP

FIG. 3—MACHINE SHOP

FIG. 4—BALANCING DEPARTMENT

New Works of Keith Blackman, Ltd.

EXTENSIVE new works and offices in Mill Mead Road, Tottenham, N.17, recently taken over by Keith Blackman, Ltd., the well-known makers of heating and ventilating plant and fans, marks a further stage in the development of this company, which originated in a small engineering business, established by Mr. George Keith in Arbroath in 1823. In 1868 the business was taken over by his eldest son, Mr. James Keith, who had the advantage of engineering experience in America, and is claimed to have been the originator of the modern sectional boiler for hot water heating, in addition to having been the inventor of a number of hydraulic, heating, ventilating, and other appliances.

The Blackman Air Propeller Ventilating Company, later known as the Blackman Ventilating Company, Ltd., was formed in 1883 with offices in the City of London and works at Holloway. The propeller type of ventilating fan was developed by this company.

In 1900 the two businesses were amalgamated under the title James Keith and Blackman Company, Ltd., and during the next two or three years the scope of the business considerably increased. The well-known system of high-pressure gas lighting was developed about this time by Mr. George Keith, the present chairman and managing director of the company, and the manufacture was begun of the "Keith" centrifugal fan. In the years that followed, the works at Arbroath and Holloway were extended from time to time until it became evident that an entirely new establishment was required in the London area to keep pace with the increasing demand for the firm's products. It was then decided to build new offices and works at Tottenham, with sufficient capacity to meet present requirements and having room for the installation of extra plant when required in the future. All the castings used and certain of the heavier types of plant are still made at the Arbroath works.

The new works, which cover a site of 10½ acres, consist in general of two blocks of buildings with a road down the centre, along the front and down one side, and bounded on the other side by a private siding giving direct access to the London and North-Eastern Railway Company's main line. At the end of the road along the front of the building, which terminates at the railway siding, a large loading bay for railway trucks has been built. This bay is served by a 10-ton overhead travelling crane, which may be controlled from the lower level of the yard or the loading platform. From here the loads are collected and distributed to the various parts of the works by Lister platform trucks and trailers. Adjoining the loading bay on one side is the works garage, over which is situated a canteen, capable of providing meals for 650 people at one sitting, and on the other is the power house shown in Fig. 1, on the opposite page.

All the electricity for the works is generated in this power house by six oil engines, supplied by Crossley Brothers, Ltd., directly coupled to Metropolitan-Vickers' alternators. Four of the generating sets have six-cylinder engines of 165 B.H.P., coupled to alternators rated at 138 kVA, and two have three-cylinder engines of 82 B.H.P., with 67½-kVA alternators. A number of rotary converters are installed to comply with the demand for D.C. required for testing equipment.

Sufficient room has been left in the power house for the installation of two further 110-kW sets at a later date. One section of this building has been walled off to house a 3000-gallon fuel tank and the cooling water circulating pumps.

The load demand on the power house varies considerably, in accordance with the number of machines undergoing electrical test, and in order to save time in notifying these changes, a system of illuminated signals has been installed.

The main electrical testing shop, shown in Fig. 2, adjoins the power house, and here there is installed complete equipment for the testing of motor-driven fans, blowers, boosters, &c. In this shop it is possible to have up to 200 machines on test at one time. For certain classes of work it is stipulated that motors and fans should be silent, so in order to test this type of machine a small silence room has been built in the test shop and completely insulated from surrounding noises.

The company makes all its own motors and a large section of the works is engaged in their production. In this department the assembly of each motor and its fan is done progressively from one end of the shop, the two being assembled as one unit before passing out for test. All the machining of the motor parts is done in this department. The larger motors are wound by men in the main shop and the smaller motors by women in an adjoining shop. Electric heating units are also assembled in the small motor-winding shop.

The end of the motor shops is walled off to form an impregnating room which is equipped for both the hot dip and bake method and vacuum impregnation. It contains eight electrically heated ovens, which are thermostatically controlled. By means of recorders, permanent temperature records are kept, and, after the articles to be impregnated go in for final baking, the ovens are controlled by synchronous time clocks.

The body of this building is occupied by the general machine shop, one section of which may be seen in Fig. 3. Here many of the older machines have been adapted for production work. As it would not have been economic to install new machines with individual electric drive, a system of driving the machines in groups of three or four, from a motor-driven overhead main shaft, has been adopted. All new machines installed incorporate individual motor drive.

The works boiler house contains two "Super Economic" boilers, supplied by H. and T. Danks (Netherton), Ltd., fitted with automatic stokers. This boiler house adjoins the railway siding and the trucks unload coal into the boot of an elevator set below rail level. The elevator raises the coal to a conveyor, which distributes it along a hopper at the top of the boiler house. This hopper runs the length of the boilers and the fuel gravitates from it down gate-controlled chutes to the stoker hoppers. The main hopper has a storage capacity of 250 tons. For heating purposes the works have been divided into seven sections, and hot water from the boilers is forced down the respective pipe lines by seven pumps in one corner of the boiler room. In keeping with its policy of providing facilities for future requirements, the company has left space for the installation of another boiler in this house. In a small shop adjoining the boiler room steam and hot water elements of heaters are tested hydraulically to 400 lb. per square inch, and with steam to 200 lb. per square inch. All the above-mentioned departments, in addition to a carpenters' shop, fitting shops, various stores, packing departments, &c., are in bays on one side of the road running through the centre of the works.

On the other side of this road are situated the shops which deal principally with the construction of ducts, fans, casings, and other sheet metal work.

One department of particular interest in this section is that shown in Fig. 4, in which all the fan runners, armatures, rotors, &c., are balanced. Four dynamic balancing machines in this department have capacities ranging from 1 oz. up to 2 tons, and six balancing tables are engaged in balancing streamline runners with diameters from 6in. to 96in. Here all rotating parts of every machine passing through the works are tested in order that vibration with its resultant noise and bearing wear is reduced to the minimum.

A considerable amount of research is continually in progress and a well-equipped experimental and research department is devoted to development work.

The whole of the works is heated by means of the company's "Unit" heaters, using hot water as the heating medium. The heaters are slung from the steel framework of the roof, and each is fitted with an adjustable nozzle to ensure the air discharged reaches working level. These units have fresh air and re-circulating inlet ducts, and are capable of giving two changes of air per hour.

In every part of the works the natural lighting is excellent and artificial illumination is provided by both gas and electricity. High-pressure gas lamps are used for general lighting, whilst electric lamps are fitted for the individual lighting of machines. Outside lighting is provided by high-pressure gas lamps suspended from bracket arms on the walls and low-pressure gas lamps, with raising and lowering gear, from columns and bracket arms. All these gas lamps and their gear are of the company's own manufacture.

A large three-storey building in one corner of the site contains the various executive offices, drawing and design departments, directors' rooms, &c. A particularly complete system of heating and ventilation has been designed and installed in this block of buildings by the company itself. It consists of a balanced system of inlet and exhaust, providing six changes of air per hour in the summer and four in the winter, exposure losses being dealt with by direct radiator warming. For winter conditions the system is designed to maintain a temperature of 65 deg. Fah. throughout the offices, with an outside temperature of 30 deg. Fah. The air-conditioning plant is centred in a room on one side of the building at ground level. Two sides of this room are mainly composed of batteries of "throw away" pad filters, through which the air is drawn, the larger impurities being deposited in the steel wool with which the filters are packed. Air is then drawn through a copper gilled pre-heater, whence it passes into a spray type double-bank washer chamber. It is finally passed through a second copper-gilled heater before being discharged into ducts for distribution round the building. These ducts are formed in the building stanchion casings in the external walls, and the air finally enters the rooms through grilles at high level. Hot water for the heaters is supplied by three cast sectional underfeed stoker boilers, made by Ideal Boilers and Radiators, Ltd., which are installed in a small boiler house adjoining the air-conditioning room.

Exhaust ventilation generally throughout the offices is by means of ducts formed over the central corridors, whence the air is drawn up, *viâ* two main ducts on either side of the central staircase by two "Multivane" fans in chambers on the roof of the building.

For winter conditions the heating plant is automatically controlled by thermostats and magnetic solenoid valves, arranged to control the dew point and final condition of the air entering the building. The main heating system is also controlled by means of a master thermostat which operates magnetic valves at the boilers.

Electric Carbonisation of Coal*

By H. STEVENS.

THE use of electricity to carbonise coal was probably first suggested in 1901 by Dr. Otto Schmidt at a meeting of the Zurich, Switzerland, Section of the Deutsche Elektrochemische Gesellschaft. The idea reappeared several times thereafter, but no contribution of practical value ever was made.

The solution of the problem, as is often the case, did not arise from consideration of these previous suggestions. It was discovered in an attack on another problem, the production of motor fuel from coal. Although this latter problem was solved technically, the recurring floods of crude petroleum in the United States since 1920 have relegated the problem of producing motor fuel to the background.

The discovery of the electric carbonising process, on the other hand, is now of major economic importance. It is especially significant in the fuel and power industries. These competing industries will soon feel the impact of the new process, for by co-ordinating them it makes the fullest possible use of capital and eliminates the waste of natural resources.

The electric carbonising process uses electricity to make coke, gas, and oil from any bituminous coal or lignite. It differs from other processes not only in that coal is heated electrically, but that a mass of coal is heated from within. This is possible because bituminous coal, which is a poor conductor of electricity, becomes a relatively good electrical conductor upon heating and during its transformation into coke. As the heating is done from within a mass of coal contained in a retort, the raw coal, which is an insulator of both heat and electricity, acts as the effective retort lining.†

The retort used for this process is cylindrical and constructed of fire-brick encased in a welded steel shell (Figs. 1 and 2). It is suspended vertically

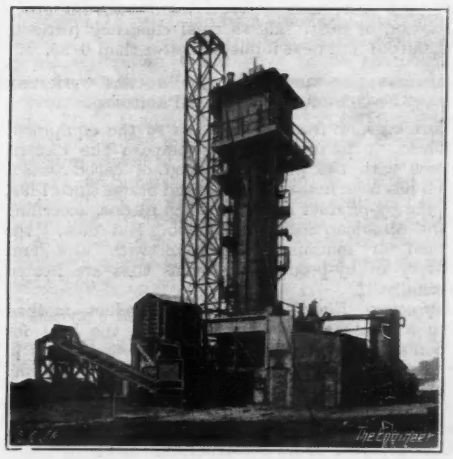


FIG. 1—*Electric Carbonising Retort*

in a steel cradle, supported by columns rising from a concrete base. The top and bottom steel covers are lined with fire-brick and through their centres pass short graphite electrodes. The top cover is electrically insulated, and the bottom cover and the steelwork are grounded.

When operating, the bottom cover is placed in position, and a vertical starting fuse, a conductor pipe filled with coke, contacting the top and bottom electrodes, is centred in the retort, which is then completely filled with coal. The charge may amount to as much as 30 net tons, depending on the variety, the size of the pieces, and the relation between these sizes and the moisture content of the coal charged. The top cover is then placed in position and the current turned on. Electricity flows through the starting fuse, heating it and the surrounding coal, driving moisture, gas, and oil outward. The layer of coal surrounding the fuse becomes coke and makes a definite path for the current, because being formed *in situ* it is compact and therefore is a better conductor of electricity than the vertical column of loose coke particles constituting the starting fuse. As carbonisation proceeds, more gas and oily vapours are

* The Electrochemical Society, New York.

† The subject was discussed in a leading article in our issue of May 12th, 1939.—ED., THE E.

driven from the coking material and fissuring occurs. The newly formed coke begins to shrink and at about 1000 deg. Cent. reaches its maximum density. The electrical conductivity of this cracked and fissured coke core is now at a minimum. Meantime the seepage of plastic material has consolidated another tubular ring of coal, which in turn forms a compact layer of coke, offering easier passage for the electric current than the inner core of shrunken coke. In this manner the zone of heat generation travels radially outward, the heat always being electrically generated adjacent to the raw coal until the entire charge is carbonised.

Gas and oily vapours driven from the heated coal pass over cold coal and are thereby scrubbed and cooled before they leave the retort through suitable outlets into collecting mains. Practically all the oil evolved during carbonisation is drained from the bottom cover. When carbonisation is completed, the top cover is lifted and any residual gas is ignited. Upon removal of the bottom cover the hot coke falls by gravity into the conveyor, where it is quenched and loaded into railway cars.

Thus is will be seen that the electrical carbonising

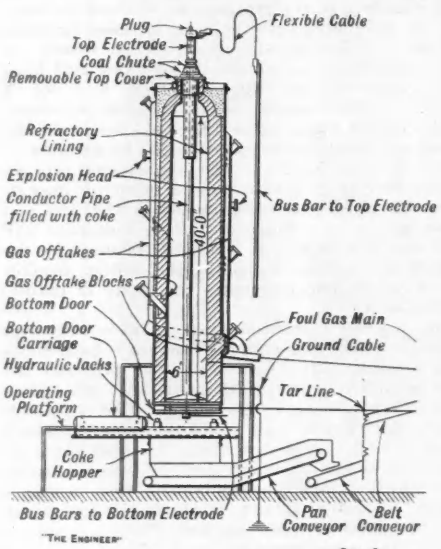


FIG. 2—*Diagram of Retort*

process, in taking advantage of all these properties of coal and coke, makes for a highly advantageous utilisation of heat. Its thermal efficiency (ratio of heat output and heat input) is better than 0·95.

COMPARISON OF THE ELECTRIC PROCESS WITH THE OLDER BY-PRODUCT PROCESS

Turning now from the process to the equipment involved, it is necessary to compare the electric process with the present method of carbonisation which has been in use in the United States since 1893, *i.e.* the by-product method, which means, according to the American Society for Testing Materials, "the method of manufacturing coke with attendant recovery of by-products in ovens that are heated externally."‡

Refractory Lining.—In the by-product method using a long narrow prismatic oven, the heat for carbonisation, generated by the combustion of gas in air in external flues, reaches the coal by passing through oven walls. A series of ovens and flues with the regenerative heating system beneath constitutes a battery. Such a battery requires over 500 different shapes of brick in its construction. Some of these, being subjected to the white heat necessary for operation, must be silica brick. Before being placed in commission these by-product ovens must be slowly dried out and gradually raised to the operating temperature (1300 deg. to 1400 deg. Cent.), a procedure requiring months. The fires once lit must never be allowed to go out, for silica brick, if allowed to cool, will disintegrate and the usefulness of the oven be destroyed.

In contrast with the by-product method oven, the electric process retort requires only a dozen different shapes of brick for its construction. These are all ordinary fire brick. The retort is made gastight by enclosing it in a welded steel shell. Other ways for making these retorts gastight can be devised. The exposed face of the fire brick only momentarily reaches the maximum temperature of approximately 1000 deg. Cent., far below the 1400 deg. Cent. of the by-product oven. In further contrast to the older oven, the electric retort requires no drying. It can be put into operation immediately on construction. The evolution of gas follows promptly on the application of current to the raw coal inside. Carbonisation can be started and stopped as often as occasion demands without damage to the apparatus or detriment to products. The wear and tear on the fire brick as well as on the graphite electrodes is practically nil. As the other equipment is scarcely ever subjected to a temperature much above atmospheric, the maintenance costs for both material and labour are low.

The differences in the generation and application of heat in the older by-product method and in the new electric process lead to a difference in the capacity of the ovens and retorts. By-product ovens operate most efficiently with their present capacity of about 15 tons of coal. The electric process operates with retorts having a capacity of 1·5 and 30 tons of coal respectively. Intermediate or larger capacity retorts can be built. The electric process uses only three-fourths of the ground area required by the by-product method. Much of this saving can be attributed to the concentration of a mass of coal in the electric retort. The widespread area occupied by the by-product ovens entails an extensive materials handling system. The electric retort requires no horizontal pusher and levelling device, as required with the by-product ovens. All of this in the electric process makes for a compact system of handling coal, coke, gas, and oil. Besides, the vapours in the electric process are scrubbed and cooled by passing over cold coal which does away with much of the cooling and scrubbing equipment essential to the operation of the by-product method. The great superiority of the electric carbonising process in point of equipment will be discovered in the low investment cost. Simplicity of design and construction, small ground area needed, and low maintenance cost all give it tremendous advantage over the present by-product method.

Coke.—Of the products of carbonisation, coke is generally recognised as having the greatest monetary value. In the electric process the largest lump coal, as well as the finest pulverised, or any intermediate size or mixture of these sizes of coal can be carbonised successfully. By the electric process a charge of 25 tons of 4in. by 6in. (10 cm. by 15 cm.) lumps of coal was coked. Despite the large volume of interspace between uniform size lumps of coal, the formation of coke proceeded as usual, in a uniformly expanding tubular ring. Even when made under this unfavourable condition, electric coke had a crushing strength of 1772 lb. per square inch (124·6 kilo. per square centimetre), as compared with 2185 lb. per square inch (153·6 kilos. per square centimetre) for by-product coke made from carefully crushed and blended coal. The amount of fine coke or breeze made by electric carbonising was the same as in the by-product ovens, about 5 per cent. by weight of the coke. The electric coke was tried out by thirty different technicians in various types of house heating furnaces with success and favourable comment, especially as to the ease with which it ignited or "picked up." The burning characteristics of any coke depend on the temperature to which it is heated. In the by-product oven the coke adjacent to the walls reaches a temperature at least 200 deg. Cent. higher than the coke at the centre of the oven. For this reason it does not have uniform burning characteristics. Because of the inherent features of the electric process and the specific electrical conductivity of coke, electrical coke is, in contrast, all uniformly heated, and has therefore uniform burning characteristics.

Gas.—Gas from the by-product method differs materially from electric gas, as may be seen from the following typical analyses which show the per cent. by volume of each constituent in the gas :—

TABLE I.—*Composition by Volume of By-product Coke Oven Gas versus Gas Made by the Electric Carbonising Process.*

	By-product gas, per cent.	Electric gas, per cent.
CO_2	2·2	0·8
Illum.	4·0	2·5
O_2	0·8	0·6
CO	6·3	8·5
H_2	46·5	61·5
CH_4	32·1	24·0
C_2H_6	—	1·3
N_2	8·1	0·8

Computation from this table shows that by-product gas weighs 337 lb. (162·9 kilos.) and electric gas 248 lb. (112·5 kilos.) per 10,000 cubic feet. This excess weight, 89 lb. (50·4 kilos.) comes from the heavy non-combustible constituents in the by-product gas. The nitrogen alone in the by-product gas weighs ten times that in the electric gas. So much dead material places a heavy tax on the gas distribution systems, because the amount of gas flowing through pipes under any conditions varies inversely as the square root of the density of the gas. The presence of nitrogen in by-product gas also gives rise to other difficulties, part of which may be overcome. Some of the inherent difficulties that cannot be overcome in the by-product method involve the larger problem of complete destruction of valuable by-products.

Ordinarily 1 ton of bituminous coal contains 30 lb. of nitrogen, or 1·5 per cent. But the coke, gas, tar, and ammonia derived from this ton of coal in by-product ovens contain 85 lb. (4·25 per cent.) of nitrogen. This excess of 55 lb. (2·75 per cent.) of nitrogen can come only from the leakage of flue gas into the ovens. This flue gas also carries oxygen into the ovens, thereby destroying some of the by-products. There is also an outward leakage of by-products from ovens into flues where they are destroyed. These leakages account for the loss of 5·6 per cent. of the coal charged. In electric carbonisation there is no such loss. Leakage is impossible. All of the products of the coal are recovered.

Tar and Oil.—Tar from the by-product method averages 9 gallons per ton (375 c.c. per kilogramme) of coal. The low-temperature oil produced by electric carbonising varies in amount from 12 to 27 gallons per ton (400 c.c. to 1125 c.c. per kilogramme) of coal, depending on the character of the coal and the rate of carbonisation. The electric oil has low specific gravity, viscosity, and low pitch content; it is high in tarry acids as compared with by-product method tar.

The commercial possibilities of electric oil have never been explored. There exists the possibility of cataphoresis or electrolysis of these tarry acids for use in the manufacture of plastics. It is possible the electric process may be extended to produce hydrogen or methane or even acetylene. Here is a vast field of development for the disciplined imagination of the electrochemist.

In the by-product oven the vapours pass over hot coke and come in contact with incandescent brickwork. The excessive heat decomposes the primary oils into heavy tars and other secondary products. In electric carbonisation the liquid products amount, on the average, to twice those from the by-product method. This may be accounted for in part by the gas-tight retort, as well as the fact that in the electric process the oily vapours are never subjected to a

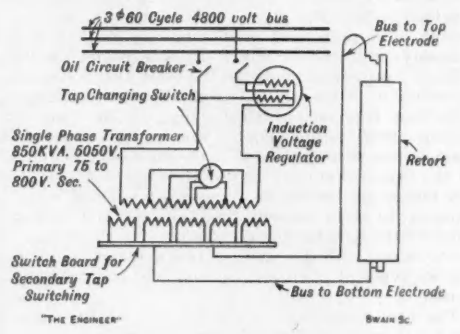

3 ϕ 60 Cycle 4800 volt bus
Bus to Top Electrode
Oil Circuit Breaker
Tap Changing Switch
Single Phase Transformer 850KVA. 5050V. Primary 75 to 800V. Sec.
Induction Voltage Regulator
Retort
Switch Board for Secondary Tap Switching
Bus to Bottom Electrode
"THE ENGINEER"
SWAIN Sc.

FIG. 3—*Diagram of Connections*

temperature higher than that at which they were evolved. The liquid by-products from electric carbonisation are thus more abundant and superior in value. In general the electric carbonising process produces a readily saleable coke that is easy to ignite and has uniform burning characteristics. From 1 ton of coal it produces 10,000 cubic feet of gas with a calorific value of 530 B.Th.U. per cubic foot (4700 kilocalories per cubic metre). This gas is lower in inerts, can be distributed at a lower cost and be used more efficiently than by-product gas. The process yields liquid products amounting to two or three times as much as those obtained from the by-product method.

Flexibility of Operation is the revolutionary attribute of the electric carbonising process. In by-product ovens the rate of heat travel averages about 1in. (25 mm.) per hour (measured on the oven width). This rate is fixed by the thermal conductivity of silica brick. Evidence substantiating this is the statement regarding operating experience with preheated coal in by-product ovens. "The charge was heated to 300 deg. Fah. (150 deg. Cent.) before charging into the ovens and the first run was coked in one-half the normal heating time. However, succeeding charges required more and more time. The reason for this lay in the heat storage in the brickwork of the oven walls, the earlier charges removing heat from the brickwork faster than it could be carried in from the oven flues."

In the electric process the rate of heat travel through the coal charge may be varied from ¼in. to 6in. (6 mm. to 150 mm.) per hour (measured on the retort diameter). The practical significance of the lower rates is that when the seasonal demand for gas decreases the electric process can, in a given time, make less gas and more oil. This electric oil can partially supplant petroleum from its secondary use as a heating fuel. In like ratio petroleum now used for heating fuel can be used for the primary purpose of supplying motor fuel. The upper rate of 6in (150 mm.) per hour for heat travel in the electric process marks only the limit of the capacity of the transformer. This limit is raised by cooling the transformer; since the maximum daily demand for gas occurs in cold weather, this cooling is done readily and effectively. Gas output of the electric process is increased in other ways. One way is by steaming the hot coke, making water gas. Another way is by injecting oil on to the hot coke, making oil gas. Still another way is to dry and preheat the coal before charging. This is not done in the by-product method, because, as stated above, there is no resulting gain in output, and, as the statement continues, because "difficulties were also encountered in pushing the charge when preheated coal was coked, increasing the possibility of oven wall damage."

Current Supply.—Current is supplied to the 30-ton retort through a single-phase, 60-cycle, 850-kVA tap transformer (Fig. 3). By means of this and the secondary switching it is possible to get a flexible and astoundingly high rate of heat travel. The starting

‡ American Society for Testing Materials, Standards on Coal and Coke, page 146, Philadelphia (1938).

and finishing voltages range from 400 down to 75. The current varies in relation to these and the rate of energy input. The power factor averages 0·85. To carbonise a ton of moist coal under sporadic operating conditions requires 350 kWh. This amount under commercial operating conditions is materially reduced. Also when dry and preheated coal is used there is a great decrease in the amount of electricity needed to carbonise a ton of coal. A gain that is equally great is effected by increasing the amount of coal carbonised in a retort in a given time. This is done by carbonising from a number of different centres simultaneously, *i.e.*, increasing the number of starting fuses in a retort. A retort having six starting fuses has been successfully operated. Such operation makes fuller use of all equipment and reduces operating costs and fixed charges per ton of coal carbonised.

Off-peak Power.—Its flexibility of operation enables the electric carbonisation process to make efficient use of the necessarily available off-peak electric power. As only one-sixth of the electricity generated in the United States is used in homes, there is a marked decrease in the output of electricity during times of slackened industrial demand such as the week-day noon hour. Just at this time of low demand for electricity there is a high demand for gas. This amounts in many cases to one-third of the total daily demand. This must be due to domestic consumption, for two-thirds of all the gas manufactured is used in homes. Electricity cannot be economically stored, but gas can be for periods of short duration. As the by-product method manufactures gas at a constant rate, peak demands must be met by storing gas in holders at the time when the demand for gas is low. The electric process meets consumers' demands by generating the gas when needed. It can do this because the rate of carbonisation can be varied from ¼in. to 6in. (6 mm. to 150 mm.) per hour or even higher.

Applications.—The greatest field for usefulness for the electric process will be in making an inexpensive, solid, smokeless fuel for heating homes. At present only one-third of our homes are using a smokeless fuel. The other two-thirds depend on bituminous coal because it is cheaper than coke, gas, oil, or anthracite. However, the burning of bituminous coal entails a tremendous loss. The presence of smoke and soot is evidence of this wastefulness. A report of tests conducted by Bituminous Coal Research, Inc., shows that bituminous coal in hand-fired heating plants is burned with an efficiency of 45 per cent., while coke burned in the same plants showed an efficiency of 70 per cent. If this waste is to be stopped, persons in the low income group must be able to buy solid, smokeless fuel at a price comparable with bituminous coal. The by-product method has failed to meet this need. The electric process can meet the need because here the operating and capital costs are low. All of the products of carbonisation are recovered. Every ton of coal carbonised by the electric process yields more products than heretofore has been possible.

To show the conditions under which this can be done, a financial set-up for the electric process is given :

TABLE II.—*Cost Data.*

DEBITS.*

	Dollars.
1 ton of moist bituminous coal	3·74
Labour, one man-hour per ton of coal carbonised	0·80
Electricity, 350kWh off-peak power at 2¼ mills per kWh	0·79
Fixed charges, 12½ per cent. on 1000 dollars capital investment per ton of coal of installed daily capacity, plant operated at capacity 250 days a year...	0·50
Maintenance, labour and materials per ton of coal carbonised	0·10
Administrative, taxes and general	1·00
	6·93
Profit	1·43
	8·36

CREDITS.

	Dollars.
Domestic coke, 0·7 ton at 6·53 dollars per ton...	4·57
Gas, 10,000 cubic feet at 0·283 dollar per 1000 cubic feet	2·83
Electric oil, 20 gallons at 0·048 dollar per gallon	0·96
	8·36

* Figures for the monetary values for coal, coke, city gas, and tar are from the U.S. Bureau of Mines, "Coke and By-product Tables," 1937, pages 3 and 21. Washington, October 15th, 1938.

Practically the only item that is disputed in the above table is the cost of off-peak electric power. Since generating plants in the United States have stood in disuse two-thirds of every year during the past thirty-eight years, the availability of off-peak electricity must be admitted. When this idle generating equipment is utilised, it will make twice the electricity necessary to carbonise all the bituminous coal mined.

Let us estimate what the cost of generating off-peak electricity might be. Recent tables give the operating cost of generating firm electricity per kilowatt-hour in modern coal-burning stations. These show: Port Washington, 2·16 mills; Gilbert, 2·34 mills; Twin Branch, 2·04 mills, an average of 2¼ mills per kilowatt-hour, which is, in fact, the average operating cost of producing all electricity (including hydro) in the United States in 1935.

The operating cost of generating off-peak electricity will be less than the cost of firm electricity given above. Less coal will be used per kilowatt-hour generated, as the coal now used for banking fires and for raising steam to warm up turbines will be generating electricity. Off-peak electricity will be made with little or no extra labour. Under such conditions the electric carbonising process can make a contribution towards fixed charges. These charges are at present borne by the user of firm electricity. In this manner the electric carbonising process will reduce the cost of electricity.

South African Engineering Notes

(By our South African Correspondent.)

CAPE TOWN, June 24th.

New Iron, Steel, and Electrical Enterprises

DR. H. J. VAN DER BIJL, chairman of the S.A. Iron and Steel Industrial Corporation (with works at Pretoria), usually referred to as "Iscor," and also chairman of the Electricity Supply Commission of South Africa, sailed for England on June 9th to organise new iron and steel and electrical enterprises in the Union. Dr. van der Bijl stated that a wing will be added to the steel plant at Pretoria for the manufacture of wire. At present a little wire for binding purposes, and barbed wire, is made at Vereeniging. But the Union consumes about 60,000 tons of wire annually and nearly all is imported. It is estimated that Iscor will be able to produce about half the Union's requirements—smooth fencing wire, barbed wire, jackal-proof fencing and wire netting. There will be no difference in price at first, but ultimately Iscor will endeavour to fix the price at a lower level. Any attempt from overseas to ruin the enterprise by dumping will be strongly resisted. The wire extension will cost about £1,500,000. It is impossible to predict the date when production will start owing to the present difficulty in securing equipment. Dr. van der Bijl, dealing with "Escom" (Electricity Supply Commission) activities, declared that when the two power stations under construction had been completed the whole of Natal would be supplied by "Escom." Portions of the Orange Free State and Transvaal will also be connected with these large power centres. "Escom" will erect a new power station at Viljoen's Drift, near the Vaal, to supply the towns and industries of the Rand. The total cost of these new "Iscor"–"Escom" schemes will be almost £5,000,000.

Iscor's Prices for Steel

Differences of opinion between the Railway Administration and the S.A. Iron and Steel Industrial Corporation, Ltd., on the prices of iron and steel material was the subject of evidence given to the Select Committee on Railways and Harbours during the second week of June. The railways stated that the method of computing prices was a matter of dispute for several years. Later agreement was reached. The price for heavy section steel rails was fixed at £8 10s. a short ton in 1937, which was raised to £9 12s. 6d. a ton in 1938. Towards the middle of 1937 the demand became so great for steel products generally that the railway could not obtain its requirements from Iscor and had to buy on the outside markets. In 1937–38 Iscor could not supply the steel required by the railways and the latter had to purchase outside at an additional cost of £21,968—for 9627 tons purchased. The chairman of Iscor informed the Select Committee that he could supply all the steel that the railways required and more, but five years ago, when an agreement was made, the railways said they could not pay the price that steel fetched on the Rand because the Rand price took into account the cost of railage from the coast to the Rand, which on an average was about £5 a ton. The railways claimed that it cost them about 5s. a ton to bring steel from the coast to Johannesburg, and they submitted they should not pay more for steel delivered f.o.r. Iscor works thought they could get it delivered at the coast. Dr. van der Bijl took up the attitude that he could sell his steel at £5 more than the railways were willing to pay and that he would supply the railways with such of their requirements as Iscor could conveniently supply. He also said that Iscor had to sell at the best price: firstly, because money must be earned for the shareholders; and secondly, because he meant to consolidate Iscor's financial position "so that nothing on earth will ever shake it." It transpired, in the course of the evidence, that the sleeper plant at Iscor was lying idle because there was a difference of opinion between the railways and Iscor. Iscor got £4 10s. a ton less for steel sold to the railways than for steel sold to outsiders, including the Public Works Department.

Development of Base Metals

A £1,000,000-a-year scheme for the development of the Union's base metal industry is being urged upon the Government of South Africa by Mr. I. Wallach, Member of Parliament for Pretoria West. It is understood that the Minister of Mines, Colonel Deneys Reitz, is giving the proposal his favourable consideration, and that the first steps will be taken next year. It is undoubtedly true, as urged by him, that considering the amounts spent on agriculture and national roads, the Union is neglecting this most important phase of its national economy. With the exception of bismuth, chrome, manganese, and asbestos, the base metal resources of South Africa have not yet been touched, though they could and should become the country's second most important industry. The geological survey of the Department of Mines is doing valuable work, and it is only costing the country about £42,500 a year. Already 65 per cent. of the Cape and 59 per cent. of the Transvaal have been surveyed. The geologists are at present busy on a coal survey of Natal and the Orange Free State. This work could be speeded up, and increased laboratory facilities for prospectors must be provided. But the State subsidy to small mines is at present £221,300 a year, and Mr. Wallach wants this to be increased to £750,000 a year, and the additional amount devoted entirely to the mining of base metals. At present the Union's export of base metals is about £2,500,000 annually. Mr. Wallach maintains that this could be increased to £20,000,000 within ten years.

Control of Scrap Metal

Following the action of Southern Rhodesia with regard to its stocks of metal, means to conserve South Africa's supplies of scrap metal and to prevent speculation by exporters seeking to exploit the heavy demands set up by the overseas armaments race are to be provided in a Bill of which the Union Minister of Commerce and Industries has recently given notice in the House of Assembly. The Bill will give power to prohibit the export of scrap metal by giving notice in the Government *Gazette*, provided a scarcity of the metal is feared. This will be done, however, only on the advice of the Board of Trade and Industries. Private firms that may be prevented by the Bill from carrying out contracts will be indemnified.

Slipway Extension at Cape Town

The shortage of dry-dock accommodation at Cape Town docks has led to strong protests from the whaling companies, which lay up their whale catchers in Table Bay on their return from the Antarctic each season for overhaul and repairs. Recently the whaling companies threatened to withdraw their craft next season unless better arrangements were made, and faced with a possible loss of about £25,000 a year in dock dues, engineers' fees, and docking charges, the Union Government has now made funds available for extension of the patent slipway. At present the slipway can take craft up to 750 tons, with accommodation for two vessels at a time, but the extension will enable four to be dealt with at the same time. The present length of the slipway is 184ft. Surveying for the big new graving dock, 1150ft. long, is continuing, but the Government has just caused consternation by a statement that before proceeding with the construction of the dry dock the Administration would have to be thoroughly satisfied that it was absolutely necessary, and that its construction was within the means of the Department. The "Dominion Monarch," 27,000-ton liner, could, the Minister informed the House of Assembly, be accommodated at the dry dock at Durban or, if necessary, at Simonstown. Durban, he pointed out, was only 700 miles from Cape Town, compared with the distance of 1200 miles between New Zealand and Australia's only dry dock. A strong agitation for proceeding with the big dry dock has been started at Cape Town.

Durban's Marine Airport

On May 24th a sluice gate was opened at the eastern corner of the new marine airport at Durban and flooding was started of the immense new excavated area which will be a flying boat base, a floating dock basin, and a new repair quay. With the flooding ten months' hard work on the major excavation project was finished. What was once a mangrove swamp is now a large basin about 8 acres in extent, varying in depth below low water sea-level from 8ft., 20ft., and 35ft. About 246,000 cubic yards of mud and clay have been excavated and removed to reclaim from the bay a long, wide mole on which hangars, offices, and the houses of the marine airport will stand. It only remains now for the dredger "Silurus," attended by her hoppers, to remove the protecting cofferdam on the northern side, and the whole area will then be open to the bay. This work is expected to take six weeks. The dredger is already at work and will be assisted by a dragline scoop working day and night on the mud wall itself.

Air Conditioned Railway Coaches

Six of the twelve air conditioned all-steel coaches which have been ordered by the South African Railways from the Metropolitan-Cammell Carriage and Wagon Company, Ltd., of Saltley, Birmingham, have arrived in the Union, and under their preliminary tests have given every satisfaction. The coaches will form two trains and will be used for luxury travel between Cape Town and Johannesburg on an improved timing. The air is cooled in summer by means of coils on the Stone system and heated electrically in winter. It is filtered before it enters the compartment, and the distribution is so arranged that the air in the compartment is always 25 per cent. new and fresh. No compartment contains more than three sleeping berths. Each full compartment is

provided with a large luggage rack and a fixed basin with hot and cold water. In the *coupés* the wash basin is of the folding type. Sleeping accommodation is provided for fifteen persons in the "A" type cars and for eleven in the "B" type. The "B" type coaches contain a two-berth compartment for attendants, a shower bath, and a hot water cistern and boiler. The safety of passengers in the event of mishap is ensured as far as possible by the rigid steel body construction, which gives great strength; but, in addition, all mirrors and windows are of armour-plate glass. The coaches have been built to specifications of the Administration. They are heavier and much stronger than the usual wood or wood and steel composite coaches.

Garratt Locomotives for Rhodesia

The engine power allocated to the Mafeking-Bulawayo section of the Rhodesia Railways is to be augmented by four Garratt locomotives of the 4–6–4 +4–6–4 type, which have been ordered from Beyer-Peacock, Ltd., of Gorton, Manchester, and which are due for delivery about the end of the year. Trains on this section are at present hauled by tenth-class locomotives of the 4–8–2 tender type, and difficulty is being experienced by these engines in maintaining the fast timings of the express passenger trains, particularly at holiday times, when loads have to be increased. The possibility of designing a locomotive of similar type to the tenth-class, but with larger boiler and higher pressure so as to increase tractive effort and provide sufficient steam for faster running on up gradients was considered. The maximum axle load of the design was, however, much in excess of that permissible on the 60-lb. rails between Mafeking and Bulawayo, and this consequently precluded further consideration of the conventional type of locomotive. The Garratt type articulated locomotive was therefore decided upon, so proportioned as to run at speeds of 45 to 50 m.p.h. on the level and at minimum speeds of from 20 to 25 m.p.h. on gradients of 1 in 80 with trains of 550 tons. The principal dimensions are as follows:—Cylinders (four), 17½in. by 26in.; coupled wheels (diameters), 4ft. 9in.; bogie wheels (diameters), 2ft. 9in.; rigid wheel base, 10ft. 6in.; boiler pressure, 180 lb. per square inch; tractive effort at 75 per cent. of boiler pressure, 37,720 lb.; water capacity, 7000 gallons; coal capacity, 10 tons. The boiler will be practically identical with the sixteenth-class Garratt, the working pressure, grate area, and principal dimensions being the same, except that the main steam pipe and the smoke-box branch pipes are slightly larger to ensure as small a drop in steam pressure as possible between the boiler and steam chests. Three boilers will each have a copper fire-box with four brick arch tubes, and the other will have a steel fire-box with two Nicholson thermic siphons and two arch tubes. The diameter of the blast pipe and chimney will be larger than the sixteenth-class engines so as to reduce back pressure as much as possible and to facilitate the exhaust steam getting away. A simple type of combined feed heater and clack-box in one mounting will be fitted on the top of the boiler between the dome and smoke-box. A similar fitting has been adopted in the new eleventh and ninth-class boilers. The coupled axle-boxes motion, spring and brake gear, and bogie control are to be lubricated by grease on the "Ajax" system. Hard grease blocks are to be used for the coupled axle-boxes, hard grease sticks for the coupling and connecting-rods, and soft grease for the motion, spring gear, and brake gears. Grease gun lubrication will be provided for the spring and brake gear similar to the system used on a motor car. The large end and coupling rod bushes will be of the floating type, the fixed bush being of steel and the floating bushes phosphor-bronze. The gudgeon pins and knuckle pins are to be of the double taper type with coned split bushes, as used on the latest sixteenth-class Garratts, which have been remarkably trouble-free. The crossheads will be of the double-bar Laird type, with the slippers between the two bars and the gudgeon pin below. Particular attention is being paid to the balancing of the revolving and reciprocating weight in order to reduce the hammer blow of the coupled wheels on the rails when travelling at speed. It is proposed to semi-streamline the front portion of the water tank on the leading unit.

Toronto's Water Supply System

MORE than ordinary interest attaches to Toronto's new water purification plant and pumping station—major units in that Canadian city's large waterworks extension scheme. In this development the general design of the buildings was influenced to a large extent by the shape and topography of the site.

The water purification plant consists of a filtered water reservoir, having a capacity of 12 million gallons, over which are constructed the filters, pipe galleries, concourse, and chemical room. For the present, twenty filters, comprising the western half of the ultimate plant, have been completed, together with the administration building, the central concourse, and the chemical section. Above the concourse and chemical section the wash-water tanks are placed.

The portion of the reservoir extending to the east of the main concourse forms the foundation for an additional twenty filters, which will give the plant an ultimate capacity of 200 million gallons daily at the standard rate of filtration of 105 million gallons per acre per day. The roof of the reservoir forms the floor of the filters and pipe gallery, and the mixing chambers and settling basins are situated within the reservoir.

The filters are arranged on either side of a single filter-operating gallery. The pipe gallery contains only the main wash water and filter effluent piping, the settled water influent and the wash water waste conduits being at the back of the filters. Each filter is 68ft. long and 35ft. 7in. wide, and has a net filter area of 2103 square feet, which, at the standard rating of 105 million gallons per acre per day, gives each unit a capacity of 5 million gallons per day. These filter units are unusually large and particular attention has been given to the design of the wash-water system in order to secure an even distribution of wash water, and therefore a uniform rate of backwash throughout the whole filter area.

The under-drain system of one filter unit consists of a concrete conduit, 3ft. square in cross section, constructed integrally with and underneath the filter floor and along its centre line. The wash water enters this conduit from a 36in. cast iron pipe in the filter pipe gallery through a 30in. hydraulically controlled gate valve, and then passes upwards through fourteen rectangular ports into a rectangular distribution manifold constructed in concrete. These ports are of sizes and spacing designed to compensate for the varying conditions of flow such as the friction loss, reduction in velocity and increase in pressure along the length of the conduit.

From the manifold the wash water will be distributed through the underdrain lateral pipes, which are designed to secure, as far as practical, equal flow through each orifice. The lateral pipes are of cast iron, 4in. in diameter at the inlet end tapering to 2½in. and are spaced 12in. apart. The orifices are on the underside and consist of brass nozzles of ¾in. bore, also spaced 12in. apart, resulting in one orifice per square foot of filter area. The outer ends of the underdrain laterals are interconnected by a cast iron manifold pipe extending along the side walls of the filter, the purpose of which is to offer a further equalising effect should the pressure in one area be greater or less than in another. The filter bed consists of graded gravel to a depth of 18in., over which is a blinding layer of coarse sand, 2in. thick. Over this again filter sand to a depth of 26in. will be placed. The filter sand will have an effective size of 0·55 mm. and a uniformity coefficient of 1·4.

The wash-water troughs are of reinforced concrete leading to a central main drain in each filter. The piping in the main gallery is of cast iron throughout, and all of the control valves are hydraulically operated. The complete control of the operation of each filter, together with the recording apparatus, is governed from an operating table situated on the operating floor, one table to each filter. The operating gallery has a terrazzo and marble floor, and skylights run throughout the entire length of the building. In order to keep down the cost of heating the building, each side of the operating gallery is enclosed with windows.

A feature worth special mention is the provision for chlorinating and de-chlorinating the filtered water. The effluent pipes from each filter discharge into a concrete filtered water conduit in the reservoir, in which a meter of rectangular section is constructed. After passing through this meter the filtered water is dispersed within a walled area at the centre of the reservoir, into which the chlorine solution is diffused. To reach the reservoir outlet the chlorinated water must travel a definite path by reason of concrete baffle walls, the purpose of which is to ensure a minimum contact period of chlorine and water when superchlorination is practised. Also the path of the water is arranged to permit of de-chlorination prior to the water leaving the reservoir.

The purpose of a Venturi meter in the filtered water conduit is to afford a continuous indication of the rate of filtration for the guidance of the chemical operators.

Chlorine and sulphur dioxide will be stored in 1-ton cylinders in the chemical storage room. The solution feed machines and evaporators will be situated in the chemical machine room directly over the reservoir and within a few feet of the point of application of the chemical. The chemical storage room is equipped with an overhead water spray system which can be controlled from outside the room in the event of a major gas leak.

The filter rate controllers are of the double butterfly valve type and are connected to a central master control which is actuated either by a float on the water level in the reservoir or manually. Under normal working conditions the maximum rate will be set on the manual control, but when the water level in the reservoir is within 1ft. of the overflow the float will regulate the rate according to the distance the water level is below the overflow.

The whole operation of the filter plant will conform closely to the standard practice used in mechanical filtration. The water will be treated with filter alum or other coagulants which will be supplied from the dry feed machines placed in a separate building. Provision has also been made for treating the water with activated carbon should it be found necessary.

One of the main features connected with the plant is the mixing and coagulating tanks. This type of mixing tank was developed by the late William Gore, and is usually referred to as the "Gore mixing tank." For the maximum rate of flow the mixing tanks have a capacity of 40 min. treatment and the settling tanks of 2 hr. 50 min. The combined mixing and settling tanks are three in number, each 389ft. 3in. in length, 90ft. in width, and 23ft. 8½in. deep. Each mixing chamber is 90ft. in width and 73ft. in length, divided into twelve separate compartments. This part of the plant was designed to produce a very gentle stirring action and distribute the flocculated water into the settling tanks without breaking up the floc, which is extremely fragile. Short circuiting was reduced to a minimum by dividing the process into several stages and by the special design of the passages. The raw water after treatment with the necessary chemicals is brought to the settling tanks by a concrete conduit running along the easterly wall. From this conduit the water enters the mixing chambers and the direction of flow from one compartment to another changes until the water finally reaches the settling tank. The coagulation obtained in these chambers is most effective and the total loss of head in passing through the various compartments will be about 4in. at normal capacity.

THE PUMPING STATION

The pumping station at Victoria Park will be an all-electric station without auxiliary power of any kind other than a relatively small supply obtained from storage batteries which will be available at all times for the automatic operation of switching equipment and for certain emergency lights and synchronous circuits. The station contains the low-lift pumps which will deliver filtered water into the distribution system.

The intake and screen section of the pumping station is built directly over the intake shore shaft and contains four (ultimately eight) mechanically operated travelling screens through which the incoming water passes to two 84in. suction headers. Each of the screens is contained in a separate compartment, which can be isolated by electrically operated sluice gates. In the construction of the screen section provision is made for a surge overflow duct which will adequately handle any surge that may be caused by stoppage of the raw water pumps owing to failure of the power supply.

The low-lift pump section contains four synchronous motor-driven single-stage centrifugal pumps, having capacities of 50, 40, 25, and 20 million Imperial gallons per day respectively, against a total head of 82ft.

The high-lift pump section contains two synchronous motor-driven, two-stage centrifugal pumps, each having a capacity of 12 million gallons daily against a net head of 191ft., and two units of similar type, each having a capacity of 18 million gallons per day against a net head of 260ft. The former units are for pumping filtered water into No. 1 District of the distribution system and the latter units will serve No. 5 District of the distribution system. In addition, the high-lift section contains three induction motor-driven, single-stage centrifugal pumps for pumping filtered water to the wash-water tanks in the filter plant to be used for back washing the filters. These pumps have capacities of 10, 7½, and 5 million gallons daily respectively, against a total head of 54ft.

The discharge pipe line from each of the raw water pumps contains a Venturi meter, and all such meters are placed in a meter gallery which lies between the pumping station proper and the chemical plant. Beyond these meters the raw water discharge pipes are merged in two groups into 84in. conduits leading to the filter plant. Each of these conduits is equipped with a controller valve, the purpose of which is to maintain automatically the level of water in the settling basin within predetermined limits.

In the equipment of the pumping station a very extensive and modern system of remote indication and control is provided for. For instance, the rate of flow, as measured by the individual Venturi meters on the raw water pumps, will be electrically totalised to control automatically the application of chemicals to the raw water. Also the rate of flow indicated by each individual Venturi meter, the degree of valve opening, suction and discharge gauge pressures, will be remotely indicated on dials in the pump control cabinets set on the pump floor, and also in some cases on similar instruments mounted on the main switchboard in the control room.

As previously stated, the Victoria Park pumping station is designed solely as an all-electric station without stand-by power of any kind. In consequence of this, the whole electrical installation from "incoming" lines to distribution busses inclusive is in duplicate, with the most modern equipment and protective devices obtainable to ensure the minimum interruption in service.

LONG TELEPHONE LINE.—Tests have begun on the 5415 miles long telegraph-telephone line between Moscow and Khabarovsk. It is reported that the line includes 174,000 poles, upon which is strung about 22,000 miles of copper wire.

Markets, Notes and News

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quotations are f.o.b. steamer. A comprehensive list of the prices of materials mentioned below will be found on the next page.

The International Steel Markets

The British steel industry is working at capacity and all available plant is being pressed into service. As a consequence, production shows an upward tendency, and although we have entered the holiday season, there is no indication of a decline in industrial operations. So heavy is the pressure upon the steel makers that one big Scottish steel works has decided to continue operations during the whole of the Glasgow fair holidays, when usually work is suspended for ten days to a fortnight. The home demand is so insistent that less attention is paid to export business than for some years, and in most cases orders for overseas destinations are seldom promised for delivery in less than ten to twelve weeks. The Continental industries are not so well occupied, with the exception of Germany, where a huge output is maintained in the face of increasing difficulties in obtaining supplies of raw material. For the second quarter of the year the German production of steel totalled 1,980,000 tons, which was 50,000 tons less than in the first quarter of last year. Most of the German export business is being transacted with markets with which clearing agreements exist, and business with the "free" markets shows a declining tendency. It is noteworthy also that Germany is not participating in the British orders for semis, which are going to France, Belgium, and Luxemburg. The report that the German steel industry intends to introduce new standards for joists and structural steel has been contradicted, but it has been announced that orders for odd sizes will be avoided so far as is possible. The Belgian and Luxemburg steel works are reported to have secured sufficient orders to ensure satisfactory working for the next four months, but at the same time the steel makers show great keenness in competing for export business, and concessions upon the official prices are obtainable for most markets. Lately there has been a fair amount of buying of Continental steel by South American countries and for those Chinese ports to which it is possible to send shipments. From the Continent also comes the report that the British Iron and Steel Federation has agreed to take from the Cartel 300,000 tons of steel between July and October, with the option of increasing the quantity. Semis will form the bulk of the orders, although a considerable tonnage of structural steel will be included. Up to June 24th Cosibel, the Cartel selling organisation, booked 160,107 tons, of which 128,719 tons were for export. The tonnage required by the home consumers of 31,316 tons is an indication of the quietness of the Belgian domestic demand. The French works are busy, largely upon home orders connected with rearmament, but have lately shared in the overseas demand for Continental steel.

British Iron and Steel Production

The British Iron and Steel Federation's statement on production in June shows that the output of pig iron rose from 692,100 tons in May to 715,700 tons, and included 111,200 tons of hematite, 476,500 tons of basic, 98,600 tons of foundry, and 15,400 tons of forge pig iron. These figures show that the production of hematite in June fell by 11,900 tons, whilst the output of basic increased by 28,900 tons. Foundry production fell by 700 tons, and the output of forge rose by 2200 tons. The foregoing indicate the great efforts which are being made to raise the production of basic to meet the heavy demand for steel materials. One furnace restarted during the month, bringing the total in blast on June 30th to 114. Steel output fell slightly to 1,175,600 tons from 1,218,100 tons during May, but this is accounted for by the shorter working month, there being twenty-six working days in June against twenty-seven in the previous month. Actually, the daily rate of operations in June increased. At the end of June 356 steel furnaces were operating, against 335 on May 31st. The following table shows the monthly average production of pig iron and steel over a period, and the output for the past six months :—

	Pig iron. Tons.	Steel. Tons.
1913.—Monthly average ...	855,000 ...	638,600
1920 " " ...	669,500 ...	755,600
1929 " " ...	632,400 ...	803,000
1931 " " ...	314,400 ...	433,500
1932 " " ...	297,800 ...	438,500
1933 " " ...	344,700 ...	585,300
1934 " " ...	497,400 ...	737,500
1935 " " ...	535,300 ...	821,600
1936 " " ...	643,500 ...	982,100
1937 " " ...	707,800 ...	1,082,000
1938 " " ...	563,600 ...	866,200
1939.—January	500,500 ...	811,700
February	516,000 ...	971,100
March	603,600 ...	1,170,900
April	608,900 ...	1,058,200
May	692,100 ...	1,218,100
June	715,700 ...	1,175,600

The Pig Iron Market

Hopes that a revival in the demand for foundry iron would take place in the first half of the year have been disappointed, and the trade has entered the holiday season without any important movement developing. It is unlikely that any change for the better will now occur before the autumn, and only then if there is a revival in the demand for the products used by the building trades. Consumers of foundry iron in all districts are pursuing a policy of buying only their immediate needs, and it is possible that the price position may be partly responsible for this. Whilst there is no evidence that the English producers are even contemplating a reduction in prices, the knowledge that quotations have not been fixed for a definite period, together with the recent reduction in the Scottish foundry iron price, lends some support to the hope that a downward revision may be made in the not distant future. North-East Coast makers are producing foundry qualities on a restricted scale and the demand remains lifeless. It is said that the stocks in the producers' hands have been reduced of late, but this is probably because the output is only intermittent. Most of the Cleveland iron passing into consumption goes to local users, but the demand for this quality is affected by the considerable imports of Midland irons into the district. The old trade which Cleveland users formerly did with Scotland has also been cut into by Midland producers, who are able to sell at about 1s. 3d. per ton below the Cleveland price. In the Midlands the requirements of the light castings industry continue well below the normal, and as a result the quantities of high-phosphoric foundry iron passing into consumption are disappointing. Some of the light castings foundries report a rather better demand for their products, but this is not the general experience, and so far as can be seen this branch of the industry is not likely to give a great deal of support to the foundry pig iron market until after the holiday season. Business in low phosphoric grades is on a satisfactory scale, although the demand is not so active as a few weeks ago. Most consumers, however, are well covered and are taking up good quantities against contracts. The situation in Scotland has not shown much change over the past week, but with the approach of the Glasgow Fair holidays business is likely to decline somewhat and last week the founders in the Falkirk district closed for the annual break. Hopes that a substantial tonnage of orders will be accumulated during the vacation, however, seem likely to be disappointed. Moderately active conditions have developed in the hematite market as a result of the reduction in the price, and specifications against contracts are growing in volume. Hopes are entertained that this movement will expand and that the stocks in the makers' hands will be materially reduced during the next few weeks.

The North-East Coast and Yorkshire

The production of steel on the North-East Coast is probably as near to theoretical capacity as the industry will attain. Practically all the existing plant available on this coast is now working. Even so, there is a tendency for deliveries to fall slightly into arrears, partly owing to the pressure exerted by consumers to accelerate their deliveries. So much of the output is going to firms engaged upon Government work, where they expect some measure of precedence that it is not surprising that discontent is expressed on the score of delivery times. Although the works employed on the production of semis are operating at full time, the output is not sufficient to meet the requirements of the re-rolling industries, but the position is being relieved to some extent by the arrival of large tonnages of Continental material, which is distributed to the local users on the North-East Coast. The demand for sheet bars in particular is insistent and lately some of the sheet mills have been hard put to maintain full operations owing to the restricted supplies of semis. It is anticipated, however, that in the coming weeks this disability will be removed by the increased imports. The works, of course, are principally engaged upon sheets for A.R.P. requirements, and this state of things is likely to obtain for many weeks to come. The shipbuilding industry is now actively employed and is taking up large tonnages of steel, a position which is in marked contrast to that existing at the beginning of the year. New orders for ships are expected to materialise shortly and these will put further pressure upon the steel makers. The largest production is, of course, that of structural steel for the constructional engineers, the majority of whom are engaged upon important Government contracts. The demand for this class of material is phenomenal and there seems a general movement to press for accelerated deliveries. New buying by this branch of the consuming industry is rather less active than recently, but this is because so many firms have booked heavily for delivery to the end of October and in a number of cases until the end of the year. The chief feature of the Yorkshire steel market is the increasing pressure to secure delivery of basic steel. The Sheffield works are operating at capacity and there is a noticeable tendency towards an expansion of delivery dates. Business in special steels appears, if anything, to be expanding, and a valuable trade is passing in A.I.D. inspected steels required by the aircraft makers. Whilst the general export demand is not particularly vigorous, the producers of mining and drill steels are an exception, and large orders have been booked for overseas destinations.

Current Business

Large extensions are being made to the works of the British Aluminium Company, Ltd., at Bank Quay, Warrington. Cardiff City Council has passed plans for the erection of a magnesium works in Colchester Avenue for International Alloys, Ltd. As from July 10th Associated Electric Vehicle Manufacturers, Ltd., Leicester and Birmingham, will centralise all departments at their factory at Webb Lane, Hall Green, Birmingham. The Birmingham factory will concentrate on chassis and the Leicester works on bodies. A company entitled Bairds and Scottish Steel, Ltd., has been formed by the amalgamation of the Scottish Iron and Steel Company, Ltd., with the coal, coke, pig iron, cement, and brick undertakings of William Baird and Co., Ltd., in Lanarkshire, Stirlingshire, Dumbartonshire, and West Lothian. The address of the selling office for the wrought iron and steel department will remain at 53, Bothwell Street, Glasgow. George Cohen, Sons and Co., Ltd., Glasgow and London, have bought the Tower of Empire, built at a cost of £60,000 for last year's Glasgow Exhibition, for scrap. The Clydebridge Steel Works of Colvilles, Ltd., by reason of "staggering" employees' holidays, will be able to remain open during the Fair period. John Cashmore, Ltd., Newport (Mon.), shipbreakers and works dismantlers, have purchased the plant and machinery at the Rogerstone Works of Guest, Keen and Nettlefolds, Ltd. Buildings and steel structures are being left standing in the hope that a new industry may be established on the site. Rubery, Owen and Co., Ltd., Darlaston, are to build a new factory for the production of aircraft parts which is expected to give employment for about 600 men. The Department of Overseas Trade announces that the following contracts are open for tender :—Pretoria, Union Tender and Supplies Board : supply, delivery, and erection, Orange Free State, of two steam boilers of the self-contained, double return tube, economic type, together with automatic stokers (Pretoria, August 3rd) ; South African Railways and Harbours Board : supply and delivery of quantities of spring steel, tapered, ribbed, square, round, and flat (Johannesburg, August 28th) ; Iranian State Railways : supply and delivery of 150 locomotives, 1866 trucks, and 120 coaches (Iran, August 26th) ; National Sanitation Works Department : two electric pumping sets and accessory plant for deep well service at San Nicolas (Buenos Aires, July 31st) ; six electric pumping sets and accessory plant (Buenos Aires, July 25th) ; number of oil-engined pumping sets for drinking water (Buenos Aires, August 1st).

Copper and Tin

The outstanding feature of the electrolytic copper market has been the development of the strong demand, the commencement of which was noticed last week. Business in this market has proceeded on a gradually increasing scale until it has assumed large proportions, and by July 7th the sales for the month had reached between 75,000 and 80,000 tons. The chief producers then began to restrict their offers and finally advanced their price by ¼c. to 10¼c., with the exception of one large concern, which was more or less out of the market. The improvement in the American market naturally had reactions in Europe and consumers bought more freely than for some weeks. The Continental demand has been fairly well spread and appears to arise principally from industrial consumers. The French Government, however, is understood to have bought heavily in the United States, a figure of 50,000 tons having been mentioned. The Japanese Government has also continued its policy of buying direct in America. It is expected that the June statistics will disclose a greatly improved position and show that the world's stocks have been materially reduced. In Great Britain consumers have continued to take considerable tonnages, although new business has not been particularly active. The quantities accepted against existing contracts, however, have been satisfactory, and it is anticipated that the demand will remain steady for some time to come. In the London standard market sentiment has been favourably influenced by the developments in the United States, but at the same time the market has been overshadowed by political developments. There has been a slight revival of speculative interest, but the general impression is that until the international political outlook becomes more stable speculators will pursue a cautious policy. . . . . Rather uninteresting conditions have ruled in the tin market over the past week. The price for cash tin has been maintained at £230 or slightly less, and occasional sales which have been attributed to the Buffer Pool have taken place at this level. The consumptive demand remains rather lethargic, in spite of the active conditions prevailing in the Welsh tin-plate industry. It is suggested, however, that there is, if anything, a tendency for the quantities of tin passing into consumption to increase, although this is not sufficient yet to have any influence upon the market. The international position is not conducive to the development of confidence, and consumers generally appear anxious to avoid forward commitments. Speculation is also affected by the political situation and by the effective control over the market which is now exercised by the International Tin Committee.

Lead and Spelter

A firmer tone has developed in the lead market than has ruled for some time, and the impression prevails that the statistical position is improving. Prices have not been greatly influenced, but it would not be surprising if values soon showed a tendency to advance. The market obviously derives considerable support from the steady consumption which is proceeding in this country and which is largely due to the demands of the trades engaged upon rearmament work. Good tonnages of the metal are being taken up by the cable makers, battery makers, and the paint trade, and recently there seems to have been rather more new buying. Most consumers, however, are well covered and are not disposed at the moment to add to their commitments. The recent improvement in the Continental demand has been maintained and this has resulted in less surplus metal being offered on the London market. The supplies of lead for near delivery are not excessive, but fresh arrivals are expected to reach this country in the latter part of the month. The strike at the Australian Broken Hill mines has now been settled and work has been resumed. It is also reported that in Spain operations at the lead mines are actively proceeding. There have been some hedging sales of lead, but this has had little influence upon prices. . . . Although the demand for spelter from consumers has slackened somewhat, the market has maintained a steady tone. Apart from the requirements of the firms engaged upon rearmament work, there is a good commercial demand and the realisation of this has helped to give the market a firm tone. The demand for high-grade spelter has become rather strong at the moment and supplies for near delivery are not easily obtainable. It is suggested that there is a possibility that the Empire producers may seek to obtain an increase in the present premium of £3 allowed upon high-grade metal. Discussions between the zinc producers in the various countries are apparently proceeding with the object of setting up a Cartel, but the general view is that little progress has been made. Difficult problems stand in the way, not the least of them being the reluctance the Continental producing countries would show to reducing their exports of the metal in any way. American statistics for June show an increase of about 2000 short tons to 135,241 tons, whilst there was a decline in the production of 42,302 tons to 39,450 tons. Deliveries were down to 37,284 tons against 39,607 tons in May.

Current Prices for Metals and Fuels

Makers' official home trade price, per ton, delivered buyers' stations. *Joists, Sections, Bars and Plates are subject to a rebate of 15s. to home users purchasing only from Associated British Steelmakers. †Export prices are for Empire Markets; for other Markets British quotations conform to Cartel prices.

PIG IRON.

Foundry home prices, except for Scotland, less rebate of 5/-.

	Home.	Export.
(D/d Teesside Area.)	£ s. d.	£ s. d.
N.E. Coast—		
Hematite Mixed Nos.	5 15 0	—
„ No. 1	5 15 6	5 15 0
Cleveland—		
No. 1	5 2 0	5 2 6
No. 3 G.M.B.	4 19 0	5 0 0
No. 4 Foundry	4 18 0	—
Basic	4 12 6	—
Midlands—		
Staffs— *(Delivered to Black Country Station.)*		
North Staffs Foundry	5 1 0	—
„ „ Forge	4 18 0 to £5 0 0	—
Basic	4 12 6	—
Northampton—		
Foundry No. 3	4 18 6	—
Forge	4 15 6 to £4 17 6	—
Derbyshire—		
No. 3 Foundry	5 1 0	—
Forge	4 18 0 to £5 0 0	—
Scotland—		
Hematite, f.o.t. furnaces	5 15 6	—
No. 1 Foundry, ditto	5 3 0	—
No. 3 Foundry, ditto	5 0 6	—
Basic, d/d	4 12 6	—
N.W. Coast— Hematite Mixed Nos.	5 15 6 d/d Glasgow 6 1 0 „ Sheffield 6 7 0 „ Birmingham	

MANUFACTURED IRON.

	Home.	Export.
Lancs and Yorks—	£ s. d.	£ s. d.
Crown Bars	12 5 0	—
Best Bars	12 15 0	—
Midlands—		
Crown Bars	12 5 0	—
Marked Bars (Staffs)	15 15 0	—
No. 3 Quality	10 17 6	—
No. 4 Quality	11 7 6	—
Scotland—		
Crown Bars	12 5 0	12 5 0
Best	12 15 0	12 15 0
N.E. Coast—		
Crown Bars	12 5 0	12 5 0
Best Bars	12 15 0	12 15 0
Double Best Bars	13 5 0	13 5 0
Northern Ireland and Free State—		
Crown Bars, f.o.q.	12 17 6	—

STEEL.

	*Home.	†Export.
London and the South—	£ s. d.	£ s. d.
Angles	10 10 6	10 0 0
Tees	11 10 6	11 0 0
Joists	10 10 6	10 0 0
Channels	10 15 6	10 5 0
Rounds, 3in. and up	11 10 6	11 0 0
„ under 3in.	11 17 6‡	11 0 0
Flats, under 5in.	11 17 6‡	11 0 0
Plates, ¼in. (basis)	10 15 6	10 2 6
„ 5/16in.	11 0 6	10 7 6
„ ⅜in.	11 5 6	10 12 6
„ 7/16in.	11 10 6	10 17 6
Un. 7/16in. to and incl. 6 lb. per sq. ft. (8-G.)	11 12 6	11 12 6
Boiler Plates, ¼in.	11 13 0	11 12 6
North-East Coast—	£ s. d.	£ s. d.
Angles	10 8 0	10 0 0
Tees	11 8 0	11 0 0
Joists	10 8 0	10 0 0
Channels	10 13 0	10 5 0
Rounds, 3in. and up	11 8 0	11 0 0
„ under 3in.	11 15 0‡	11 0 0
Plates, ¼in. (basis)	10 10 6	10 2 6
„ 5/16in.	10 15 6	10 7 6
„ ⅜in.	11 0 6	10 12 6
„ 7/16in.	11 5 6	10 17 6
Un. 7/16in. to and incl. 6 lb. per sq. ft. (8-G.)	11 12 6	11 12 6
Boiler Plates, ¼in.	11 8 0	11 12 6
Midlands, and Leeds and District—	£ s. d.	£ s. d.
Angles	10 8 0	10 0 0
Tees	11 8 0	11 0 0
Joists	10 8 0	10 0 0
Channels	10 13 0	10 5 0
Rounds, 3in. and up	11 8 0	11 0 0
„ under 3in.	11 16 0‡	11 0 0
Flats, 5in. and under	11 15 0‡	11 0 0
Plates, ¼in. (basis)	10 13 0	10 2 6
„ 5/16in.	10 18 0	10 7 6
„ ⅜in.	11 3 0	10 12 6
„ 7/16in.	11 8 0	10 17 6
Un. 7/16in. to and incl. 6 lb. per sq. ft. (8-G.)	11 12 6	11 12 6
Boiler Plates, ¼in.	11 10 6	11 12 6

STEEL (*continued*).

	*Home.	†Export.
Glasgow and District—	£ s. d.	£ s. d.
Angles	10 8 0	10 0 0
Tees	11 8 0	11 0 0
Joists	10 8 0	10 0 0
Channels	10 13 0	10 5 0
Rounds, 3in. and up	11 8 0	11 0 0
„ under 3in.	11 15 0‡	11 0 0
Flats, 5in. and under	11 15 0‡	11 0 0
Plates, ¼in. (basis)	10 10 6	10 2 6
„ 5/16in.	10 15 6	10 7 6
„ ⅜in.	11 0 6	10 12 6
„ 7/16in.	11 5 6	10 17 6
Un. 7/16in. to and incl. 6 lb. per sq. ft. (8-G.)	11 12 6	11 12 6
Boiler Plates, ¼in.	11 8 0	11 12 6
South Wales Area—	£ s. d.	£ s. d.
Angles	10 8 0	10 0 0
Tees	11 8 0	11 0 0
Joists	10 8 0	10 0 0
Channels	10 13 0	10 5 0
Rounds, 3in. and up	11 8 0	11 0 0
„ under 3in.	11 15 0‡	11 0 0
Flats, 5in. and under	11 15 0‡	11 0 0
Plates, ¼in. (basis)	10 13 0	10 2 6
„ 5/16in.	10 18 0	10 7 6
„ ⅜in.	11 3 0	10 12 6
„ 7/16in.	11 8 0	10 17 6
Un. 7/16in. to and incl. 6 lb. per sq. ft. (8-G.)	11 12 6	11 12 6

Ireland—F.O.Q.—	Belfast.	Rest of Ireland.
	£ s. d.	£ s. d.
Angles	10 13 0	10 15 6
Tees	11 13 0	11 15 6
Joists	10 13 0	10 15 6
Channels	10 18 0	11 0 6
Rounds, 3in. and up	11 13 0	11 15 6
„ under 3in.	12 0 0‡	12 2 6
Plates, ¼in. (basis)	10 15 6	10 18 0
„ 5/16in.	11 0 6	11 3 0
„ ⅜in.	10 5 6	11 8 0
„ 7/16in.	11 12 6	12 10 0
Un. 7/16in. to ½in. incl.	11 12 6	11 12 6

‡ *Rounds and Flats tested quality; untested, 3s. less.*

OTHER STEEL MATERIALS

Sheets.	Home. £ s. d.	Export, f.o.b. £ s. d.
11-G. and 12-G., d/d	13 15 0	11-G. to 14-G. 11 5 0
13-G., d/d	14 2 6	15-G. to 16-G. 11 15 0
14-G. to 20-G., d/d	14 10 0	17-G. to 18-G. 12 0 0
21-G. to 24-G., d/d	14 15 0	19-G. to 20-G. 12 5 0
25-G. and 26-G., d/d	15 10 0	21-G. to 22-G. 12 17 6

South Africa, Rhodesia, Nyasaland, £14; Canada, £14 12s. 6d., f.o.b. basis. Irish Free State, £14 15s., f.o.q., 4-ton lots.

The above home trade sheet prices are for 4-ton lots and over; 2-ton to 4-ton lots, 7s. 6d. per ton extra; and under 2-ton lots to 10-cwt., £2 per ton extra.

Galvanised Corrugated sheets, basis 24-G.—

Home.	£ s. d.
4-ton lots and up	17 5 0
2-ton to 4-ton lots	17 12 6
Under 2 tons	18 17 6

Export: India, £17 15s. c.i.f.; Irish Free State, £17 5s., f.o.q.; General, £15 15s., f.o.b., 24-G. basis.

Tin-plates—
20 by 14 basis, f.o.t., Bristol Channel Ports, 20s. 4½d.
Tin-plate Bars, d/d Welsh Works, £7 5s.

Billets—100-ton lots and over, 35 to 100 tons, 5s. extra; less than 35 tons, 10s. extra.

	£ s. d.
Soft (up to 0·25% C.), untested	7 7 6
„ „ „ tested	7 12 6
Basic (0·33% to 0·41% C.)	7 17 6
„ Medium (0·42% to 0·60% C.)	8 10 0
„ Hard (0·61% to 0·85% C.)	9 0 0
„ „ (0·88% to 0·99% C.)	9 10 0
„ „ (over 0·99% C.)	10 0 0
Rails, Heavy, 500-ton lots, f.o.t.	9 10 0
„ Light, f.o.t.	8 10 0

FERRO ALLOYS.

	Per Ton.	Per Unit.
Tungsten Metal Powder	4/9½ per lb. (nominal)	
Ferro-Tungsten	4/8 per lb. (nominal)	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£23 10 0	7/6
„ „ 6 p.c. to 8 p.c.	£23 5 0	7/6
„ „ 8 p.c. to 10 p.c.	£23 5 0	7/6
„ „ Max. 2 p.c. carbon	£36 0 0	11/-
„ „ „ 1 p.c. carbon	£38 5 0	11/-
„ „ „ 0·5 p.c. carbon	£41 0 0	12/-
„ „ „ carbon-free	10d. per lb.	
Metallic Chromium	2/5 per lb.	
Ferro Manganese (loose), 76 p.c.	£16 15 0 home	
„ Silicon, 45 p.c. to 50 p.c.	£12 10 0 scale 5/- p.u.	
„ „ 75 p.c.	£17 0 0 scale 6/- p.u.	
„ Vanadium	14/- per lb.	
„ Molybdenum	4/10 per lb. 5/- forward	
„ Titanium (carbon-free)	9d. per lb.	
Nickel (per ton)	£185 to £190 per ton	
Cobalt	8/6 to 8/9 per lb.	

NON-FERROUS METALS.

(Official Prices, July 12th.)

Copper—	
Cash	£42 13 9 to £42 15 0
Three Months	£43 0 0 to £43 1 3
Electrolytic	£49 0 0 to £49 5 0
Best Selected Ingots, d/d Birmingham	£49 0 0
Sheets, Hot Rolled	£80 0 0

	Home.	Export.
Tubes, Solid Drawn (basis)	12¾d.	12¾d.
„ Brazed (basis)	12¾d.	12¾d.
Brass—		
Ingots, 70/30, d/d Birmingham	£38 5 0	
Tubes, Solid Drawn 2/1 Alloy	11½d.	11½d.
„ Brazed	13½d.	13½d.

Tin—	
Cash	£229 15 0 to £230 0 0
Three Months	£224 10 0 to £224 15 0
Spelter—	
Cash	£14 2 6 to £14 3 9
Three Months	£14 6 3 to £14 7 6
Lead—	
Cash	£14 13 9 to £14 16 3
Three Months	£14 16 3 to £14 18 9
Aluminium Ingots (British)	£94 (net)

FUELS.

SCOTLAND

	Export.
Lanarkshire—	
(f.o.b. Grangemouth)—	
Navigation Unscreened	18/- to 18/6
Hamilton Ell	17/6
Splints	20/-
Ayrshire—	
(f.o.b. Ports)—	
Steam	17/-
Fifeshire—	
(f.o.b. Methil or Burntisland)—	
Prime Steam	18/-
Unscreened Navigation	18/6
Lothians—	
(f.o.b. Leith)—	
Hartley Prime	18/-
Secondary Steam	16/9

ENGLAND

South Yorkshire, Doncaster—	
Steam Hards	19/- to 20/-
Washed Smalls	16/- to 17/-
Northumberland, Newcastle—	
Blyth Best	19/- to 19/6
„ Second	18/- to 18/6
„ Best Small	15/6
Unscreened	17/- to 18/-
Durham—	
Best Gas	19/6
Foundry Coke	26/- to 28/-

SOUTH WALES

Cardiff—	
Steam Coals:	
Best Admiralty Large	23/6 to 24/-
Best Seconds	23/- to 23/6
Best Dry Large	23/- to 23/6
Ordinaries	23/-
Bunker Smalls	16/- to 17/6
Cargo Smalls	15/- to 15/6
Dry Nuts	27/6 to 28/-
Foundry Coke	35/- to 42/6
Furnace Coke	33/6
Patent Fuel	25/6
Swansea—	
Anthracite Coals:	
Best Large	36/- to 38/-
Machine-made Cobbles	41/- to 45/6
Nuts	40/- to 45/-
Beans	33/- to 38/6
Peas	26/- to 30/-
Rubbly Culm	15/- to 16/-
Steam Coals:	
Large Ordinary	22/6 to 24/6

FUEL OIL.

Inland consumption: contracts in bulk.

Exclusive of Government tax of 1d. per gallon; and 9d. per gallon on oil for road vehicles.

Ex Ocean Installation—	Per Gallon.
Furnace Oil (0·950 gravity)	3¾d.
Diesel Oil	4½d.

French Engineering Notes

(From our own Correspondent in Paris.)

Civil Defence

AT the end of last week the National Railway Company despatched a demonstration train on the first stage of a three months' tour through the country with the object of bringing as much of the population as possible into direct touch with the problems of passive defence against air raids. It had remained a week at the Gare de l'Est in Paris before proceeding to the East of France. The train includes two vans, one fitted up with what is necessary for civil defence and the other with moving picture displays giving visible impressions of what should be done for protection. While covering the usual special means of protection, the exhibit deals particularly with palliative measures for those who will be evacuated from towns and cities and will certainly not all be provided with gas masks and other safety equipment. It is made clear that no part of France can be immune from air attack, though it would probably be concentrated on industrial areas, hydro-electric power stations, railways, and strategical positions. Nevertheless, everyone must be prepared for bombs and gas. While the train was in Paris, the lecturer accompanying it explained that if war breaks out all train services will be stopped at noon on the same day, and special trains will then run to evacuate women, children, and sick and aged persons. As all valid men will be mobilised, those left in areas liable to intense bombardment will be engaged in active defence or in works and factories and other services that must be carried on. Among the exhibits are models of what each individual evacuated should wear and carry, with a list of essential articles to be packed in a knapsack and a sailor's bag. In each arrondissement of Paris the evacuated population will be sent to a particular region, where lodgings will be provided by committees under the direction of the Passive Defence Department of the Ministry of Defence. Special attention is given to the identification of children, for at the time of the last war 6000 small children were, it is affirmed, separated from their parents and lost and have never been identified. In one compartment of the van old sleepers are cut in lengths and assembled with spiked clamps in a manner to demonstrate their utility for strengthening cellars to be used as shelters. A couple of unskilled men can saw and erect them in an underground shelter, packed on the top to the ceiling with sandbags, in a very short time. There are immense stocks of old sleepers available for this purpose. Where possible, an ante-chamber should precede the underground shelter, such as steps leading down to the cellar, which should be constantly sprayed with an alkaline solution during a gas attack, and woollen blankets saturated with a strong solution of carbonate of soda should close this ante-chamber and the shelter. When not in use the blankets are rolled up over the tops of the doors. Everything is done in the cheapest way possible for those who are unable to undertake more elaborate safety measures and is practically within the means of the whole community. Simple instructions are given in leaflets distributed by the Passive Defence Department. As an example, soft soap makes an excellent gasproof joint, and it is curious how many articles and products in daily use are turned to account. While relative protection from gas can be assured for everybody in this way, it is possible that simple instructions may be forgotten at critical moments, and societies exist to see that the elementary measures prescribed are carried out, and one of them, constituted eight years ago, claims to have instructed more than 900,000 men and women who can take charge of first aid, shelters, and other arrangements in the event of air raids.

Paris Omnibuses

The law requiring that 10 per cent. of all public service vehicles shall be run on suction gas or other home-produced fuels will come into operation on January 1st next year, but the S.T.C.R.P., as the company operating the services in Paris and the Department of the Seine is called, will appeal to the Government for a postponement of the law's application in its particular case. For a long time the company has been carrying out trials with suction gas producers on omnibuses in service, but the results are not satisfactory, and the idea of using suction gas has been abandoned until something is done to eliminate the drawbacks of producers for intensive public services and to lessen maintenance costs. The situation of the S.T.C.R.P. requires that it must pursue a policy of strict economy. It is true that the total receipts last year increased as the result of higher fares, but the number of passengers carried declined seriously, to the extent that it has been found necessary to postpone, and, if possible, avoid a further raising of fares that was to have been imposed a couple of months ago. A continuous decline of passenger traffic through higher fares will inevitably lead to an ultimate fall in receipts and to the omnibuses failing to provide a real public service. The company is doing everything possible to avoid a further increase of fares. Being under the control of a committee that was formed by the Government towards the end of last year with a view to ensuring a more economical organisation of public transport in the Department of the Seine, the company has suppressed a large number of lines and continues to effect a cohesion of the omnibus system. It must now reduce running costs to a minimum. Four omnibuses are in service with compression ignition engines, and the saving in fuel cost is so appreciable that the use of these engines is likely to become general. For the moment the problem is to meet the requirements of the law to run a percentage of the omnibuses on home-produced fuels. As there were 3700 omnibuses at the end of last year, something like 370 of them will have to be so equipped. Outside Paris, it is hoped to run trolleybuses with recuperation of the type designed by Monsieur Bacqueyrisse and tried with complete success many years ago. Nothing further was done with it through failure to come to terms with electricity supply companies at a time when conditions were different from what they are now. There is no question of running trolleybuses within Paris, where compressed coal gas may possibly be used in the absence of anything better, but neither coal gas nor electricity comes within the spirit of the law, which seeks mainly to develop the use of forest products.

British Patent Specifications

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

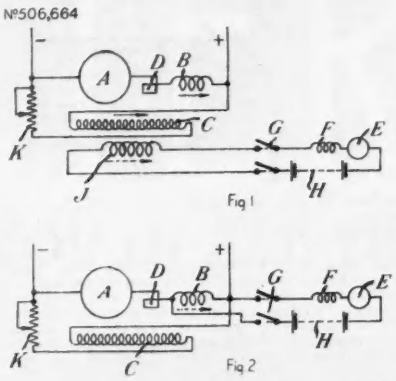
Copies of Specifications may be obtained at the Patent Office, Sales Branch, 25, Southampton Buildings, Chancery Lane, W.C.2, 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

DYNAMOS AND MOTORS

506,664. December 1st, 1937.—ENGINE-DRIVEN ELECTRIC GENERATOR SETS FOR EMERGENCY LIGHTING, Thomas Bousfield Somerville, of 11, Entwisle Avenue, Davyhulme, Manchester; Alexander Greenwood Williamson, of 25, Litherland Road, Sale, Manchester; and Metropolitan-Vickers Electrical Company, Ltd., of Number One, Kingsway, London, W.C.2.

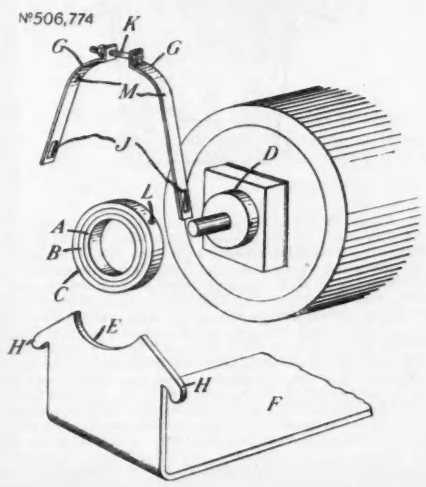
This invention applies to engine-driven electric generator sets for emergency lighting and other purposes where the full generator voltage is required as soon as possible after the starting up of the petrol engine or other prime mover driving the electric generator. In both the drawings, A represents the



armature of the generator, which obviously may be an exciter generator for the field of a main generator; B is the series field winding of the generator, and C the shunt field winding. D represents the interpole field winding. At E is shown the armature and at F the series field winding of the starter motor, which is adapted to be connected by the switch G through the storage battery H to the auxiliary generator field winding J (Fig. 1), or to the ordinarily provided generator series field winding B (Fig. 2), during the starting of the engine, which may be coupled to the shafts of both the generator A or exciter A and the starter motor E. A rheostat K is provided in the shunt field winding circuit of the generator.—*June 1st*, 1939.

506,774. January 5th, 1938.—RESILIENT MOUNTING RINGS FOR MOTORS, The English Electric Company, Ltd., of Queen's House, 28, Kingsway, London, W.C.2, and John Walton Bottomley, of Phœnix Works, Bradford, Yorkshire.

In the resilient motor mounting described in this specification, use is made of a resilient sleeve unit comprising a complete cylindrical inner metal sleeve A, a similar outer sleeve C, and an annular layer of rubber B between them. The inner sleeve A is adapted to fit tightly over and thereby embrace and hold the housing D of the motor end bearing. The lower half of the outer sleeve C can rest in a semi-circular recess in a vertical supporting bracket E for the motor, which may be of sheet metal and integral with a base portion F. A clamping

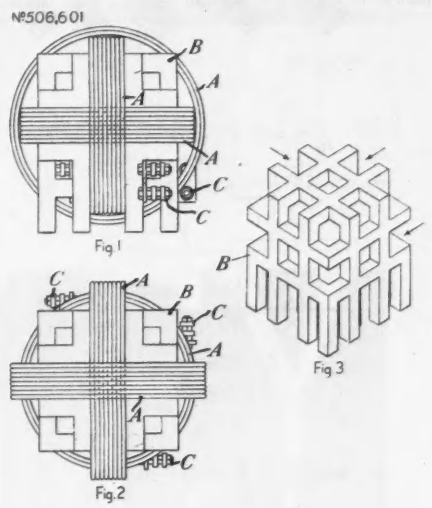


strip G, in two separate parts, passes around the upper half of the outer sleeve C and clamps the whole unit to the supporting bracket E. It is provided with two projecting hooks H and the two half-clamping strips are each apertured at J at the lower end to fit over one of the hooks H, so that when the nut on the screw K which passes through holes in the upturned ends of the clamps G is tightened, it pulls the two half-clamps G tightly against the outer sleeve C and the bracket E. Indentations L are provided in the outer surface of the outer sleeve C, into which can fit corresponding projections provided either on the clamps G, as shown at M, or on the bracket G, or on both, whereby the resilient mounting unit is positively held against rotation relatively to the bracket.—*June 5th*, 1939.

ELECTRICAL APPLIANCES

506,601. January 21st, 1938.—CHOKE COILS FOR USE IN ELECTRIC POWER DISTRIBUTING SYSTEMS, George Ellison, Ltd., of Wellhead Lane Works, Perry Barr, Birmingham, 20; and James Anderson, of the same address.

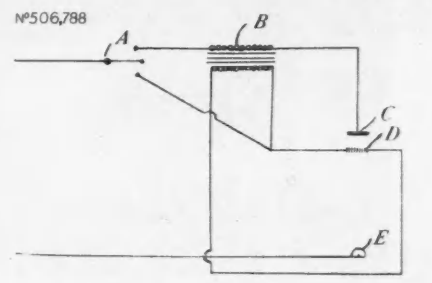
The object of this invention is to provide improved multi-phase reactors. Figs. 1 and 2 are respectively a side elevation and a plan of a three-phase reactor constructed in accordance with the invention. Fig. 3 is a perspective view of the coil support or former of the reactor. Three short toroidal or annular windings A, each wound from conductors of appropriate dimensions, are employed. These windings are adapted to be mounted one within another so that they have a common centre, and they are arranged in three different planes at right angles to each other. The windings A may be mounted on a non-magnetic



support B, which in the example shown has the form of a skeleton framework made from wood or other convenient non-magnetic material and shaped to provide guides for the coils. The arrows shown in Fig. 3 indicate the positions occupied by the coils. The support B also carries terminals C, whereby the reactor is connected to the electric power distributing system. For some purposes it is advantageous to employ instead of the support B an iron support for the coils A.—*June 1st*, 1939.

506,788. December 1st, 1937.—ARC DISCHARGE ARRANGEMENTS FOR CONVERTING ELECTRIC CURRENTS, Thomas Hamilton-Adams, Roxwell, near Chelmsford, Essex.

Means are described in this specification for periodically interrupting vapour arcs. Within the arc-containing member is a perforated secondary anode between the main anode and the cathode. The circuit of the main anode contains the primary windings of a transformer, the secondary of which has connected across its terminals the secondary anode, so that when current passes through the primary windings a current is set up in the secondary anode, thus breaking the primary circuit. The consequent failure of the current in the primary anodial circuit causes reversal of polarity in the secondary circuit, permitting



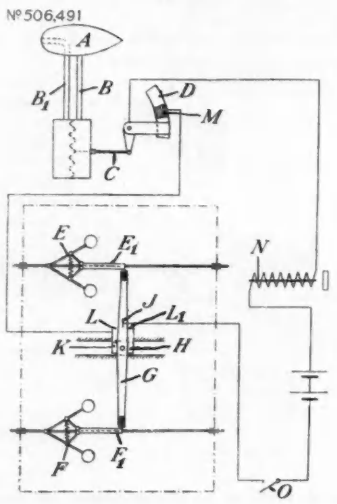
current again to flow from the cathode through the secondary anode to the main anode. Hence oscillation is established. If the arc-containing member is furnished with two primary and two perforated secondary anodes, and these two secondary anodes are connected oppositely to each other to the secondary of the transformer, the primary of which is in the main anodial circuit, oscillation will be set up between one or other of these primary anodes alternatively and the cathode. In starting it is preferable to be able to switch the current directly on to the secondary anode for striking the arc. A is the switch, B the transformer, C and D the main and secondary anodes respectively, and E the cathode within the vapour arc container. —*June 1st*, 1939.

AERONAUTICS

506,491. December 1st, 1938.—MEANS FOR THE CONTROL OF THE ENGINES OF MULTI-ENGINE AIRCRAFT, Arado Flugzeugwerke Gesellschaft mit beschrankter Haftung, Brandenburg (Havel), Germany.

If, with high-speed multi-engine aeroplanes, one of the side engines stalls on starting or shortly after starting, there is a danger that the opposing force exercised by the lateral directing gear may be insufficient to balance the unilateral thrust. According to the invention, for cutting out an engine or engines in order to bring about balance of the aeroplane, a circuit is automatically closed on the stalling of one engine, there being included in the circuit a device, for example, a relay, which effects engine control, and also two switches, of which one only is influenced within a predetermined dynamic pressure range by a Pitot tube, and the other is adapted to be closed by a switch member influenced by the difference in the rotational speeds of the engines. In the accompanying drawings A denotes a Pitot tube which is connected by way of a static pressure conduit B and a dynamic pressure conduit B_1 with a casing. A diaphragm within the casing is connected by a rod C with a bell crank switch lever. D is a segment, the hatched portion of which designates a switch contact. E and F are two centrifugal governors actuated by the respective engines, not shown. The outward movement of the governor fly weights is transmitted by links to adjusting members E_1, F_1, each of which is provided with an arm engaging loosely a bifurcation in a switch member G. The two governors are thus interconnected by way of the switch member. The switch member is pivoted on a fulcrum pin carried by a slide H mounted in a parallel slideway. The switch member carries a contact J; a double contact K is connected with the slide H. At the two sides of the slide the double contact has limbs each presenting a contact L or L_1 within the range of the contact J. The contact portion M of the segment D is connected by a conductor with the contact K. From the switch lever shaft a second conductor is led to the switch contact J. Interposed in the circuit containing this conductor is a relay N with an armature. In the same circuit is also included a battery. O denotes a manually operable switch adapted to be closed by the pilot to bring the device into a condition ready for use. The operation is as follows:—Let it be assumed that the switch O

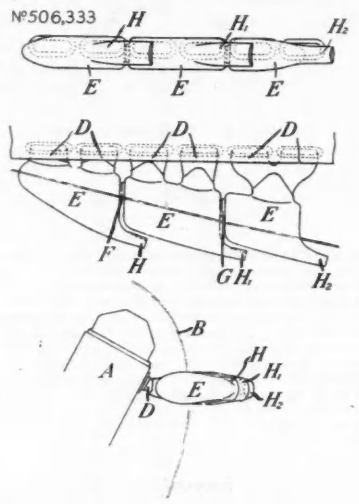
is in closed position and that the aeroplane is just starting or has just started. There is then exercised a dynamic pressure which flexes the diaphragm in the casing so that through the action of the rod C the switch lever is rocked to effect closure of the contact M. If at this moment, for example, the side engine, not shown, which drives the centrifugal governor E should stall, then by the alteration of the distance of the fly weights of the governor from the axis of rotation the upper end of the switch member G is moved to the right while the lower end remains in its position. At this time the contact J engages the contact L_1



and closes the battery circuit while the slide H is shifted to the right. By the closure of the circuit the relay N is energised and attracts the armature. The movement of the armature effects the shutting off of both engines with the utilisation of any known auxiliary means, not shown. If the engine actuating the centrifugal governor F should stall a similar sequence is followed. When the two engines and thus also the two centrifugal governors run at approximately the same rate the switch member G, the slide H, and the contact K remain in the mean position shown in the drawing and the contact is kept open.—*May 30th*, 1939.

506,333. September 24th, 1937.—EXHAUST PIPES FOR INTERNAL COMBUSTION ENGINES OF AIRCRAFT, James Edwin Ellor, Grandell, South Drive, Chain Lane, Mickleover, Derby; and Rolls-Royce, Ltd., Nightingale Road, Derby.

The exhaust system illustrated in the drawings serves an engine having two banks of cylinders arranged in a V, one of the banks being shown at A. The engine is contained in a cowling B. Each bank has six cylinders, the exhaust gases from which pass into short pipes D. Three expansion boxes E are connected together by short lengths of piping F and G, and each of these collects the gases from two of the pipes D. Each box has a rearwardly projecting nozzle H, H_1, and H_2 with orifices shaped



as shown in Fig. 3, those of nozzles H, H_1 being crescent shaped and that of H_2 being oval. These nozzles are tapered and restricted and operate to increase the kinetic energy of the gases at the point of discharge. The group of boxes together forms a member of flattened streamline shape except for the necessary departure therefrom due to accommodating the discharge orifices. In the example shown only a part of the streamline member lies outside the cowling. It may, however, be wholly outside. The rearwardly projecting nozzles have two advantages. Firstly, less disturbance to the external airstream is caused by the discharge of the gases; and secondly, the kinetic energy of the gases discharged from the nozzles may create a forward thrust on the aircraft.—*May 24th*, 1939.

FURNACES

506,366. July 26th, 1938.—GLASS FURNACES, British Thomson-Houston Company, Ltd., Crown House, Aldwych, London, W.C.2.

In order to maintain a uniform temperature in glass furnaces and preserve the heat balance thereof, the batch material must be introduced into the furnace gradually and must be evenly distributed therein. These precautions are particularly desirable when the furnace is electrically heated by the passage of current through the bath of molten glass, since the batch material, when introduced, is a good insulator and only becomes conductive upon being heated and even then varies considerably in resistance with changes in temperature. One of the objects of this invention is to provide apparatus for satisfactorily feeding batch material to a glass furnace. Another object is to provide apparatus for feeding the batch material gradually and for distributing it evenly over a large area in the melting tank. The batch feeder comprises a hopper A mounted above the open melting tank of the glass furnace. The hopper extends substantially the full length of the tank and its sides are inclined to form an opening which extends the full length of the hopper and allows the batch material to pass to the plate B below. The batch material is quite granular and of uneven consistency, so that it piles upon the plate and prevents additional material from passing from the hopper. Feeding occurs when the plate B is swung back and forth across the opening in the hopper, which results in the batch material being partially dumped and partially shaken from the plate. The extent and rate of the oscillation of the plate control the amount of material fed. The plate is caused to oscillate by a roller C which is located in a slot in an arm D and is mounted excentrically on the end of the shaft of a speed reducer which is driven by an electric motor E. The excentricity of the mounting for the roller, which may be varied, controls the amount of movement of the plate. Oscillation of the

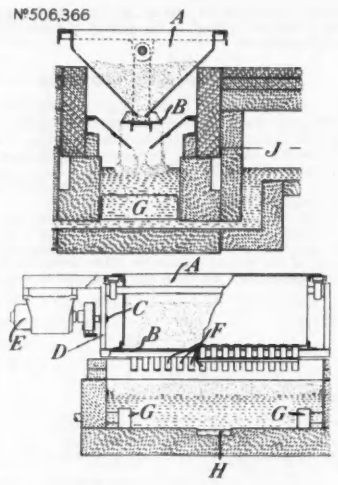
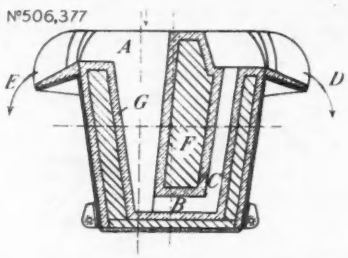


plate from side to side causes the material to be gradually sprinkled on to the inclined stationary fingers F at both sides of the apparatus, which break up the flow of the material so that it is quite evenly distributed over the surface of the partially melted batch in the furnace tank. In this instance the furnace is heated by the passage of electric current through the molten glass between the electrodes G G, and the semi-molten glass batch floating on top of the molten glass shields and insulates the feeding apparatus from the heat of the molten glass. The molten glass flows through openings H in both sides of the furnace to the forehearths J at each side and replaces that used therefrom.—*May 26th*, 1939.

METALLURGY

506,377. November 29th, 1938.—IMPROVEMENTS IN PASSAGE VESSELS FOR SEPARATING PIG IRON AND SLAG, Dortmund-Hoerder Hüttenverein Aktiengesellschaft, 173, Rheinische-strasse, Dortmund, Germany.

This invention relates to and has for its object to provide an improved construction of passage vessel for use in separating pig iron and slag and particularly slag containing soda. As is well known, the de-sulphurisation of pig iron with soda is nowadays used to an increasing extent. The slag formed thereby, which contains large proportions of alkalies, however, strongly attacks the refractory lining of the mixer. With a view to preventing the used soda slag from getting into the mixer a passage vessel has therefore been used, into which the pig iron coming from the blast-furnace is poured; the soda slag is retained in view of the siphon construction of the passage vessel, the pig iron running out of the latter being free from soda slag. The pig iron coming out of the passage vessel is brought either into an intermediate container or directly into the pig iron mixer. It is true that the attack of the soda slag on the refractory lining

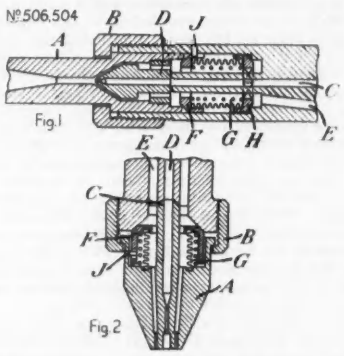


is thus prevented, but the attack of the slag is diverted to the refractory lining of the passage vessel with the effect that the passage vessel has frequently to be relined with refractory material. According to the invention, very great durability of the refractory lining of the passage vessel is obtained by providing a refractory lining consisting of the same composition from which refractory carbon bricks are made, viz., preferably of finely ground coke mixed with tar, which acts as a binder. The composition need not be fired, it being sufficient to use it as a ramming composition. A passage vessel according to the invention is described by way of example. The vessel has on one side at A a funnel-shaped inlet, through which the pig iron passes by way of the channels B and C to the overflow D, which is arranged at a level low enough to permit a satisfactory flowing off of the pig iron, while the de-sulphurising slag, which floats on the pig iron during the pouring into the funnel, may overflow continuously at E. The lining composition F consists of a carbon brick composition, and the covering G consists of a composition like that usual for refractory bricks.—*May 26th*, 1939.

MISCELLANEOUS

506,504. November 27th, 1937.—GAS-TIGHT JOINT FOR AUTOGENOUS WELDING BURNERS, I.G. Farbenindustrie Aktiengesellschaft, Frankfurt a/Main, Germany.

This invention relates to an improved device for making gas-tight the joint between the gas tube and the burner nozzle in an autogenous welding burner or a cutting blow-pipe. The object is to prevent completely intermixture of the gases supplied to the burner and any escape of gases into the atmosphere without preventing easy renewal of the burner nozzle and the device itself. The drawing, Fig. 1, shows the arrangement of a welding burner. The burner head A is held in a recess in the end of the handle by means of the screw collar B. The rear end face of the nozzle D abuts against the mouth of the oxygen duct C. A rigid joint is thus produced. The gas flowing through the duct E is prevented from escape by the movable washer F abutting against the inner edge of the collar of the burner head and supported by one end of the corrugated tube G, the other end of which is mounted to abut against the disc H. The disc abuts against a corresponding seating surface in the interior of the handle. In order to attain a sufficient tightening pressure a compression spring is mounted between the washer F and the disc H. To constitute a removable distance piece the washer F, the corrugated tube G, the compression spring, and the disc H are connected together and the disc is screwed into the end of the recess in the handle; a square hole serves for the screwing and unscrewing. After the screw collar and the burner head have been removed a socket wrench slid over the mouth of the duct C can be inserted into this square hole. Fig. 2 shows the arrangement of a cutting burner. The burner nozzle A is held by the screw collar B on the end of the handle. The rigid joint C is situated at the



mouth of the duct D for the oxygen. This oxygen duct is surrounded by the duct E for the mixture of oxygen and gas. When the screw collar is tightened the movable washer F is pressed against the inclined surface of the handle and is kept in a tight position by the corrugated tube G and the compression spring. In this case the corrugated tube is soldered to the nozzle so that the tightening parts are not readily removable. If required, however, these parts may be constructed as a distance piece, as illustrated in Fig. 1, to be screwed in the nozzle so that they can be removed easily after removal of the collar B and cleaned or exchanged for new parts. In both cases a pin J prevents torsion of the tightening parts.—*May 30th*, 1939.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

British Waterworks Association

Tuesday to Saturday, July 25th to 29th.—Summer meeting at Nottingham.

Institution of Civil Engineers

Saturday, July 15th.—MANCHESTER ASSOC.: Visit to Southport. 2.30 p.m.

PERSONAL AND BUSINESS ANNOUNCEMENTS

W. W. CONSTANTINE, consulting engineer, informs us that as from July 8th last his address is Grosvenor Gardens House, Grosvenor Gardens, London, S.W.1.

BLACKSTONE AND CO., Ltd., of Stamford, Lincs, announce that they have opened a new department in their London office in Kingsway to deal exclusively with the sale of Blackstone-Brush diesel engines.

THE MACHINE TOOL TRADES ASSOCIATION announces that Mr. W. J. Morgan, A.M.I. Mech. E., late of the Board of Trade and Technical Adviser to the Import Duties Advisory Committee, has been appointed secretary of the Association.

HONEYWELL-BROWN, Ltd., manufacturers of controlling and recording instruments, inform us that their offices and works have been moved to Wadsworth Road, Perivale, Greenford, Middlesex. Telephone and telegraphic addresses are Perivale 5691 and Minnreg, Greenford, respectively.

FREDERICK BRABY AND CO, Ltd., of Glasgow, inform us that Mr. George H. Ferguson has been appointed general manager of the Scottish branches of the company. Mr. Ferguson has been with the firm for over forty years and for a period acted as assistant manager. Mr. James P. MacKinnon has been appointed assistant manager.

LAUNCHES AND TRIAL TRIPS

BARWON, steamship; built by Caledon Shipbuilding and Engineering Company, Ltd.; to the order of Huddart Parker, Ltd.; dimensions, length 360ft., breadth 50ft., depth 27ft. 3in.; deadweight, 5500 tons. Engines, triple-expansion, working in conjunction with a low-pressure turbine; constructed by J. G. Kincaid and Co., Ltd. Launch, June 30th.

T. H. WATERMEYER, steam tug; built by A. and J. Inglis, Ltd.; to the order of the South African Railways and Harbours Adminstration; dimensions, length 145ft., breadth 33ft., depth 17ft., gross tonnage 600. Engines, two triple-expansion, developing 2500 I.H.P.; constructed by Lobnitz and Co., Ltd. Launch, July 6th.

CATALOGUES

DAVIDSON AND CO., Ltd., Belfast.—Publication on the "Sirocco" air washer.

GENERAL ELECTRIC COMPANY, Ltd., Magnet House, Kingsway, W.C.2.—Ironclad switchgear catalogue.

HUGH WOOD AND CO., Ltd., Gateshead-on-Tyne, 11.—Leaflet describing "Huwood" oil-filled conveyor rollers.

HENRY PELS AND CO., Ltd., 32–38, Osnaburgh Street, London, N.W.1.—Publication giving illustrated specifications of presses, shears, and punches in stock.

MARCONI'S WIRELESS TELEGRAPH COMPANY, Ltd., Electra House, Victoria Embankment, W.C.2.—Leaflet No. 1310 on the "Marconitrack" blind approach beacon receiver, Type A.D. 66.